YAMAHA
YAMAHA MOTOR CO., LTD.

YAMAHA SINGLE-AXIS ROBOT FLIP-X series

N15/N18

User's Manual

ENGLISH E

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Before using the N15/N18 single-axis robots (Be sure to read the following notes.)

Thank you for purchasing this YAMAHA single-axis robot N15/N18.
Before using this robot, read the following notes and set the origin position.

The N15/N18 single-axis robots use absolute position detectors that do not require return-to-origin after turning on the controller power. However, when the controller power is turned on in the following cases, return-to-origin must be performed just the very first time.

(1) When robot cable was first connected after delivery from YAMAHA.

(2) When robot cable was disconnected from the controller and then reconnected.

(3) When no absolute battery is connected.

(4) When a motor or cable was replaced.

At this point, any of the following errors is issued immediately after controller power is turned on, **but this is not a malfunction**. The controller will operate normally by restarting.

When using an SRCX controller:

15 : FEEDBACK ERROR 2

23 : ABS.BAT.L-VOLTAGE

24 : ABS.DATA.ERROR

... etc.

When using an RCX142 controller:

17.81 : D?.ABS.battery wire breakage

17.92 : D?.Resolver disconnected during power off

17.93 : D?.Position backup counter overflow

... etc.

Setting the origin position

Set the origin position by referring to the following section in the robot controller user's manual.

When using an SRCX controller:

See “9-1-1 Performing return-to-origin” in Chapter 9.

When using an RCX142 controller:

See “11-8 Absolute Reset” in Chapter 4.

CAUTION

Changing the origin position to the opposite side of the initial position may cause a position shift or robot breakdowns, so use caution.
Avoid changing the origin detection method since it is dangerous in some cases. If the origin position must be changed, please consult our sales office or dealer.

After setting the origin position, affix the stickers (triangular stickers supplied with the robot) to both the tool side and workpiece side so that they can be used as the alignment marks. Use these marks as the reference position the next time the origin position must be set.

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About this manual

This manual consists of the following chapters.

Chapter 1 Using the Robot Safely

Chapter 2 Product Overview

Chapter 3 Installation and Connections

Chapter 4 Periodic Inspection and Maintenance

Chapter 5 Troubleshooting

Chapter 6 Specifications

- This manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.
- Specifications of robot models other than standard models may be omitted in this manual if they are common to those of standard models. In this case, refer to the specifications of standard models.
- For details on specific operation and programming of the robot, refer to the separate "YAMAHA Robot Controller User's Manual".
- To operate or adjust the robot safely and correctly, refer to the instruction manual by any of the following methods and comply with the instructions.
  1. Refer to the printed version of the manual (available for an additional fee).
  2. View the contents of the CD-ROM version of this manual on your computer screen.
  3. Refer to a printout of the necessary pages from the CD-ROM version of this manual.

The contents of this manual are subject to change without prior notice.
While every effort has been made to ensure the contents of this manual are correct, please contact us if you find any part of this manual to be unclear, confusing or inaccurate.

MEMO

Chapter 1 Using the Robot Safely

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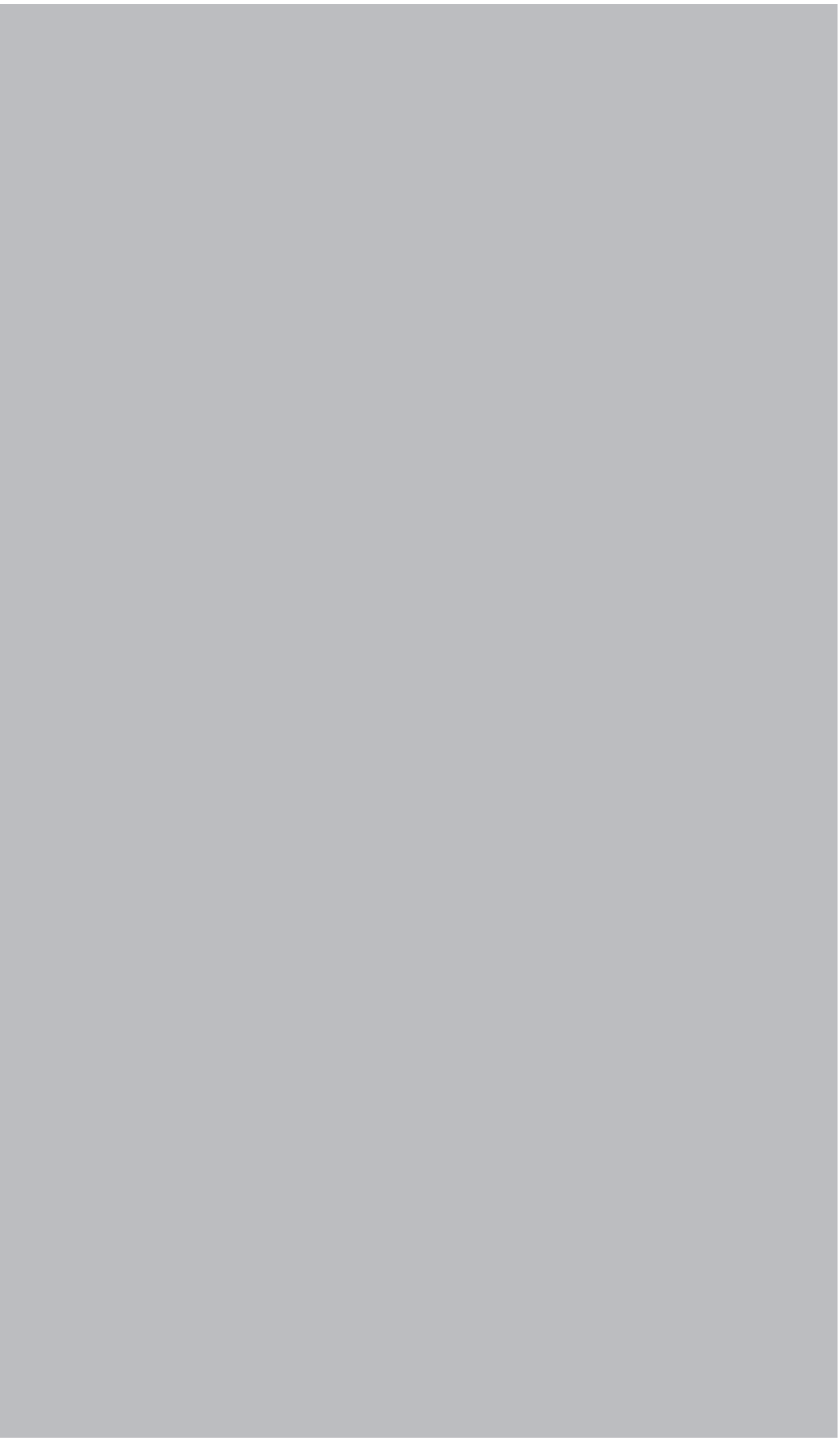


1-1 Safety information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks. To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS included in this manual. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning symbols and signal words used in this manual are classified as explained below. Make sure that you fully understand the meaning of each symbol and comply with the instructions.

DANGER

FAILURE TO FOLLOW DANGER INSTRUCTIONS WILL RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

WARNING

FAILURE TO FOLLOW WARNING INSTRUCTIONS COULD RESULT IN SEVERE INJURY OR DEATH TO THE ROBOT OPERATOR, BYSTANDERS OR PERSONS INSPECTING OR REPAIRING THE ROBOT.

CAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, bystanders or persons inspecting or repairing the robot, or damage to the robot and/or robot controller.

NOTE

Explains the key point in the operation in a simple and clear manner.

Reference

Gives useful information related to the robot operation.

It is not possible to list all safety items in detail within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation.
For specific safety information and standards, refer to the applicable local regulations and comply with the instructions.
This manual and warning labels supplied with or affixed to the robot are written in English. If the robot operator or service personnel do not understand English, do not permit that person to handle the robot.

1-2 Essential precautions

Particularly important cautions for handling or operating the robot are described below. In addition, precautions during installation, operation, inspection and maintenance are also provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

(1) Observe the following cautions during automatic operation.

- Install a safeguard (safety enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
- Install a safety interlock that triggers emergency stop when the door or panel is opened.
- Install a safety enclosure so that no one can enter inside except from doors or panels equipped with safety interlocks.
- Warning labels 1 are supplied with the robot and should be affixed to conspicuous spots on doors or panels equipped with safety interlocks.

DANGER
SERIOUS INJURY OR DEATH WILL RESULT FROM IMPACT WITH MOVING ROBOT.
- **KEEP OUTSIDE OF GUARD DURING OPERATION.**
- **LOCK OUT POWER BEFORE APPROACHING ROBOT.**

(2) Use caution to prevent hands or fingers from being pinched or crushed.

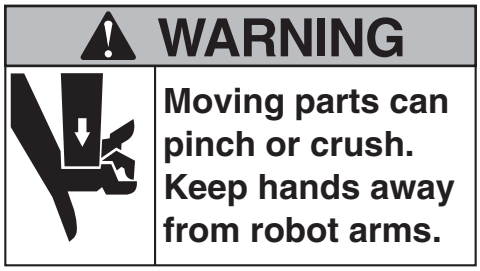
Warning label 2 is affixed to the robot.
Use caution to prevent hands or fingers from being pinched or crushed by the moving parts when carrying the robot or during teaching.

WARNING
MOVING PARTS CAN PINCH OR CRUSH.
KEEP HANDS AWAY FROM ROBOT ARMS.

Warning label 1

DANGER
Serious injury or death will result from impact with moving robot.
• Keep outside of guard during operation.
• Lock out power before approaching robot.

Warning label 2



(3) Follow the instructions on warning labels and in this manual.

- Be sure to read the warning labels and this manual carefully and make sure you thoroughly understand their contents before attempting installation and operation of the robot.
- Before starting robot operation, be sure to reread the procedures and cautions relating to your work as well as descriptions in this chapter (Chapter 1, "Using the Robot Safely").
- Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.
- The warning labels 3 are supplied with the robot and should be affixed to the robot or conspicuous spots near the robot.

WARNING

IMPROPER INSTALLATION OR OPERATION CAN RESULT IN SERIOUS INJURY OR DEATH.
READ THE USER'S MANUAL AND ALL WARNING LABELS BEFORE OPERATION.

Warning label 3

WARNING
Improper installation or operation can result in serious injury or death. Read user's(owner's) manual and all warning labels before operation.

(4) Do not remove, alter or stain the warning labels.

WARNING

IF WARNING LABELS ARE REMOVED OR DIFFICULT TO SEE, THEN ESSENTIAL PRECAUTIONS MIGHT NOT BE TAKEN, RESULTING IN ACCIDENTS.

- DO NOT REMOVE, ALTER OR STAIN THE WARNING LABELS ON THE ROBOT.
- DO NOT ALLOW THE WARNING LABELS TO BE HIDDEN BY DEVICES INSTALLED ONTO THE ROBOT BY THE USER.
- PROVIDE PROPER LIGHTING SO THAT THE SYMBOLS AND INSTRUCTIONS ON THE WARNING LABELS CAN BE CLEARLY SEEN EVEN FROM OUTSIDE THE SAFETY ENCLOSURE.

(5) Do not use the robot in environments containing inflammable gas, etc.

WARNING

- THIS ROBOT WAS NOT DESIGNED FOR OPERATION IN ENVIRONMENTS WHERE INFLAMMABLE OR EXPLOSIVE SUBSTANCES ARE PRESENT.
- DO NOT USE THE ROBOT IN ENVIRONMENTS CONTAINING INFLAMMABLE GAS, DUST OR LIQUIDS. EXPLOSIONS OR FIRE MIGHT OTHERWISE RESULT.

(6) Do not use the robot in locations possibly subject to electromagnetic interference, etc.

WARNING

AVOID USING THE ROBOT IN LOCATIONS SUBJECT TO ELECTROMAGNETIC INTERFERENCE, ELECTROSTATIC DISCHARGE OR RADIO FREQUENCY INTERFERENCE. MALFUNCTIONS MIGHT OTHERWISE OCCUR.

(7) Provide safety measures for end effector (gripper, etc.).

WARNING

- **END EFFECTORS MUST BE DESIGNED AND MANUFACTURED SO THAT THEY CREATE NO HAZARDS (FOR EXAMPLE, A WORKPIECE THAT COMES LOOSE) EVEN IF POWER (ELECTRICITY, AIR PRESSURE, ETC.) IS SHUT OFF OR POWER FLUCTUATIONS OCCUR.**
- **IF THERE IS A POSSIBLE DANGER THAT THE OBJECT GRIPPED BY THE END EFFECTOR MAY FLY OFF OR DROP, THEN PROVIDE APPROPRIATE SAFETY PROTECTION TAKING INTO ACCOUNT THE OBJECT SIZE, WEIGHT, TEMPERATURE AND CHEMICAL PROPERTIES.**

(8) Use caution when removing the motor.

WARNING

THE VERTICAL AXIS WILL SLIDE DOWN WHEN THE MOTOR IS RELEASED, CAUSING A HAZARDOUS SITUATION.

- **TURN OFF THE ROBOT CONTROLLER AND PROP UP THE VERTICAL AXIS WITH A SUPPORT STAND BEFORE REMOVING THE MOTOR.**
- **BE CAREFUL NOT TO LET YOUR BODY GET CAUGHT BETWEEN THE VERTICAL AXIS PARTS AND INSTALLATION BASE.**

(9) Be careful not to touch the motor and peripheral parts when hot.

WARNING

The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched. Before handling these parts during inspection or servicing, turn off the controller, wait for a while and check that the parts have cooled.

(10) Consult us for corrective action when the robot is damaged or malfunctions occur.

WARNING

IF ANY PART OF THE ROBOT IS DAMAGED OR ANY MALFUNCTION OCCURS, CONTINUING THE OPERATION MAY BE VERY DANGEROUS. PLEASE CONSULT YOUR YAMAHA SALES OFFICE OR DEALER FOR CORRECTIVE ACTION.

Damage or Trouble	Possible Danger
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot

(11) Protective bonding

WARNING

BE SURE TO GROUND THE ROBOT AND CONTROLLER TO PREVENT ELECTRICAL SHOCK.

(12) Be sure to make correct parameter settings.

CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If these are not correct, drive unit service life may end prematurely, and damage to robot parts or residual vibration during positioning may result.

(13) Take the following safety precautions during inspection of controller.

WARNING

- WHEN YOU NEED TO TOUCH THE TERMINALS OR CONNECTORS ON THE OUTSIDE OF THE CONTROLLER DURING INSPECTION, ALWAYS FIRST TURN OFF THE CONTROLLER POWER SWITCH AND ALSO THE POWER SOURCE IN ORDER TO PREVENT POSSIBLE ELECTRICAL SHOCK.
- NEVER TOUCH ANY INTERNAL PARTS OF THE CONTROLLER.
- REFER TO THE "YAMAHA ROBOT CONTROLLER USER'S MANUAL" FOR PRECAUTIONS ON HANDLING THE CONTROLLER.

(14) Follow the specified procedures when installing, adjusting or inspecting the robot.

WARNING

ALWAYS FOLLOW THE SPECIFIED PROCEDURES WHEN INSTALLING, ADJUSTING OR INSPECTING THE ROBOT. NEVER ATTEMPT ANY PROCEDURE NOT DESCRIBED IN THIS MANUAL.

(15) Do not attempt any repair, parts replacement and modification.

WARNING

DO NOT ATTEMPT ANY REPAIR, PARTS REPLACEMENT AND MODIFICATION UNLESS DESCRIBED IN THIS MANUAL.
THESE WORKS REQUIRE TECHNICAL KNOWLEDGE AND SKILL, AND MAY ALSO INVOLVE WORK HAZARDS.

1-3 Special training for industrial robot operation

Companies or factories using industrial robots must make sure that every person, who handles the robot such as for teaching, programming, movement check, inspection, adjustment and repair, has received appropriate training and also has the skills needed to perform the job correctly and safely. Since the YAMAHA N15/N18 robots fall under the industrial robot category, the user must observe local regulations and safety standards for industrial robots, and provide special training for every person involved in robot-related tasks (teaching, programming, movement check, inspection, adjustment, repair, etc.).

1-4 Robot safety functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power.

(2) Overheat detection

This detects an abnormal temperature rise in the controller driver and shuts off the servo power.

If an overload or overheat error occurs, take the following measures.

1. Insert a timer in the program.
2. Reduce the acceleration coefficient.

(3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.

Note: The working envelope is the area limited by soft limits.

(4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range.

Note: The movement range is the area limited by mechanical stoppers.

WARNING

ROBOT MOVEMENT WILL NOT STOP IMMEDIATELY AFTER THE SERVO POWER SUPPLY IS SHUT OFF BY EMERGENCY STOP OR OTHER SAFETY FUNCTIONS.

1-5 Safety measures for the system

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper instruction manual for safe, correct operation and servicing of the system.

1-6 Trial operation

After making installations, adjustments, inspections, or maintenance or repairs to the robot, make a trial run using the following procedures.

(1) If a safety enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safety enclosure, and observe the following points.

1. Use sturdy, stable posts which will not fall over easily.
2. The rope or chain should be easily visible by everyone around the robot.
3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.

(2) Check the following points before turning on the controller.

1. Is the robot securely and correctly installed?
2. Are the electrical connections to the robot correct?
3. Are items such as air pressure correctly supplied?
4. Is the robot correctly connected to peripheral equipment?
5. Have safety measures (safety enclosure, etc.) been taken?
6. Does the installation environment meet the specified standards.

(3) After the controller is turned on, check the following points from outside the safety enclosure.

1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
2. Does each axis move as intended within the soft limits?
3. Does the end effector move as intended?
4. Are the signal transmissions to the end effector and peripheral equipment correct?
5. Does emergency stop work?
6. Are the teaching and playback functions normal?
7. Are the safety enclosure and interlock working as intended?
8. Does the robot move correctly during automatic operation?

1-7 Work within the safety enclosure

(1) Work within the safety enclosure

When work is required inside the safety enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.

1) Soft limit settings

2) Teaching

For item 1), follow the precautions and procedure for each section. To perform item 2), refer to the description in (2) below.

(2) Teaching

When performing teaching within the safety enclosure, comply with the instructions listed below.

1) Check or perform the following points from outside the safety enclosure.

1. Make sure that no hazards are present within the safety enclosure by a visual check.
2. Check that the programming unit HPB (option) operates correctly.
3. Check that no failures are found in the robot.
4. Check that emergency stop works correctly.
5. Select teaching mode and prohibit automatic operation.

2) Never enter the movement range of the manipulator while within the safety enclosure.

1-8 Automatic operation

Automatic operation described here includes all operations in AUTO mode.

(1) Check the following before starting automatic operation.

1. No one is within the safety enclosure.
2. The programming unit and tools are in their specified locations.
3. The alarm or error lamps on the robot and peripheral equipment do not flash.
4. The safety enclosure is securely installed with safety interlocks actuated.

(2) Observe the following during automatic operation or in cases where an error occurs.

1) After automatic operation has started, check the operation status and signal light to ensure that the robot is in automatic operation.

2) Never enter the safety enclosure during automatic operation.

3) If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safety enclosure.

   1. Press the emergency stop button to set the robot to emergency stop.
   2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

1-9 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following applies:
(1) After 18 months (one and a half year) have elapsed from the date of shipment
(2) After one year has elapsed from the date of installation
(3) After 2,400 hours of operation

Exceptions to the Warranty : This warranty will not apply in the following cases:
(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)
(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).
(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

1) Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or man-made disasters.
2) Troubles caused by procedures prohibited in this manual.
3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
4) Use of any other than genuine parts and specified grease and lubricants.
5) Incorrect or inadequate maintenance and inspection.
6) Repairs by other than authorized dealers.

YAMAHA MOTOR CO., LTD. MAKES NO OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. THE WARRANTY SET FORTH ABOVE IS EXCLUSIVE AND IS IN LIEU OF ALL EXPRESSED OR IMPLIED WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES ARISING FROM A COURSE OF DEALING OR USAGE OF TRADE.
YAMAHA MOTOR CO., LTD. SOLE LIABILITY SHALL BE FOR THE DELIVERY OF THE EQUIPMENT AND YAMAHA MOTOR CO., LTD. SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES (WHETHER ARISING FROM CONTRACT, WARRANTY, NEGLIGENCE OR STRICT LIABILITY). YAMAHA MOTOR CO., LTD. MAKES NO WARRANTY WHATSOEVER WITH REGARD TO ACCESSORIES OR PARTS NOT SUPPLIED BY YAMAHA MOTOR CO., LTD.

Chapter 2 Product Overview

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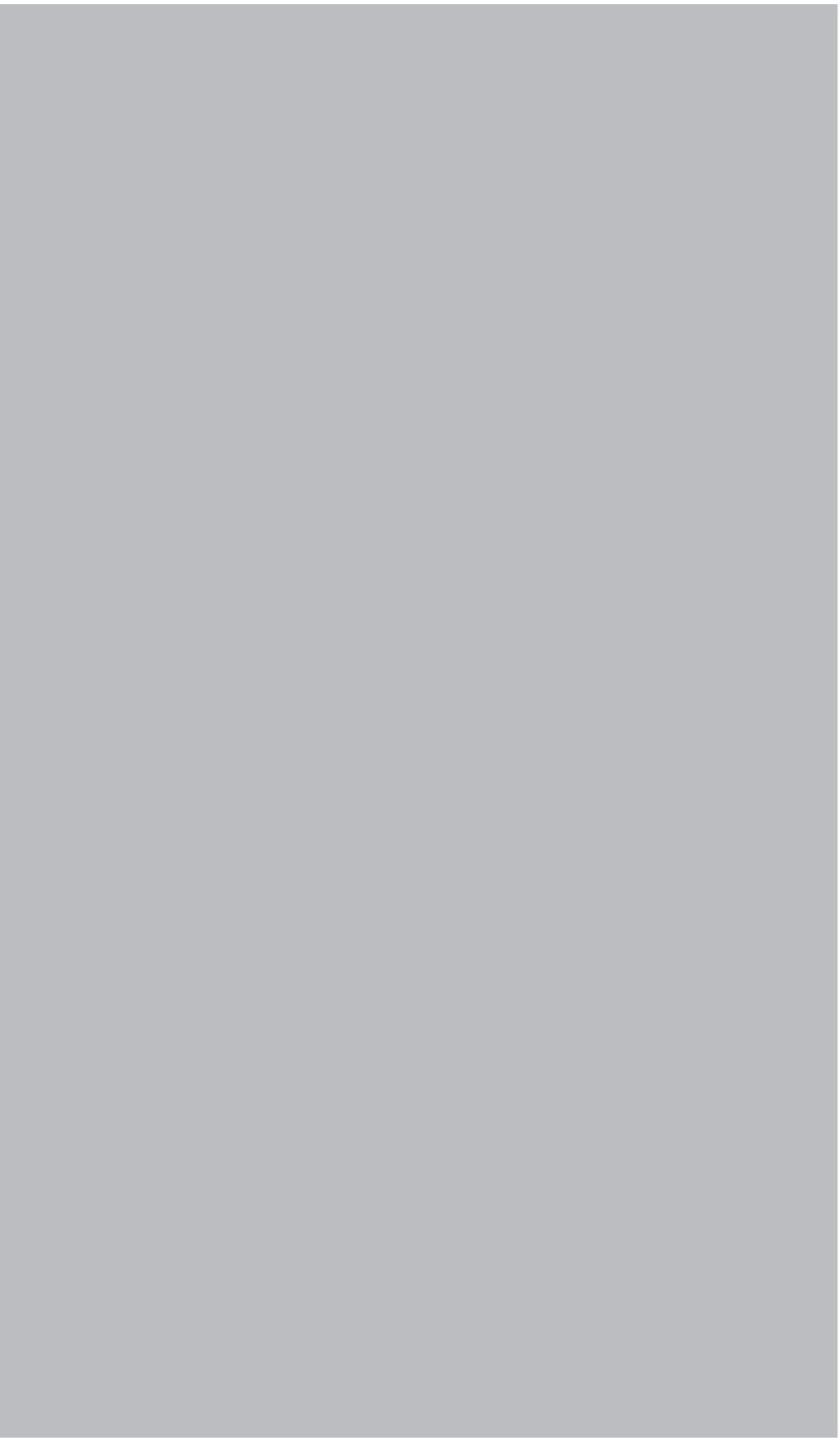


2-1 Checking the product

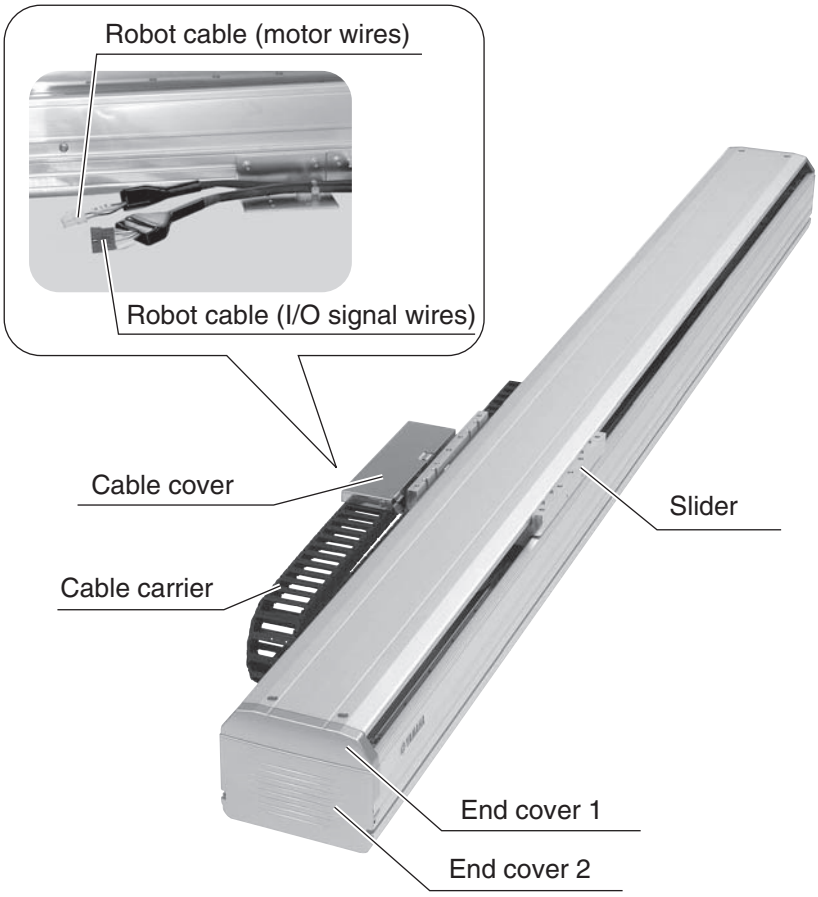
After unpacking, make sure that all components and accessories are included (as specified in your order). Also check the product for any damage on the exterior which might have occurred during shipping.
If there are any missing parts or damage due to shipping, please notify your YAMAHA sales office or representative immediately.

WARNING

- **ALWAYS USE TWO OR MORE PEOPLE TO TAKE THE ROBOT UNIT OUT OF THE PACKAGE. EACH PERSON SHOULD GRIP THE ROBOT UNIT NEAR ONE END FROM THE LOWER SIDE. CARRY WITH THE ROBOT FACING UPWARD (SLIDER SIDE UPWARDS).**
- **WHEN UNPACKING, CAREFULLY HOLD THE ROBOT NOT TO DROP IT. IF THE ROBOT FALLS, SERIOUS INJURY MAY OCCUR OR THE ROBOT MAY BE DAMAGED.**

2-2 Robot part names

Robot part names
External components



Reference

The direction of the cables coming out of the cable carrier depends on the specifications you ordered. The above illustration shows an example of RH (right and horizontal) type.

2-3 Robot internal structure

The YAMAHA N15/N18 single-axis robots are truly innovative single-axis robot using a hollow motor as its drive source. The internal robot structure and features are described here.

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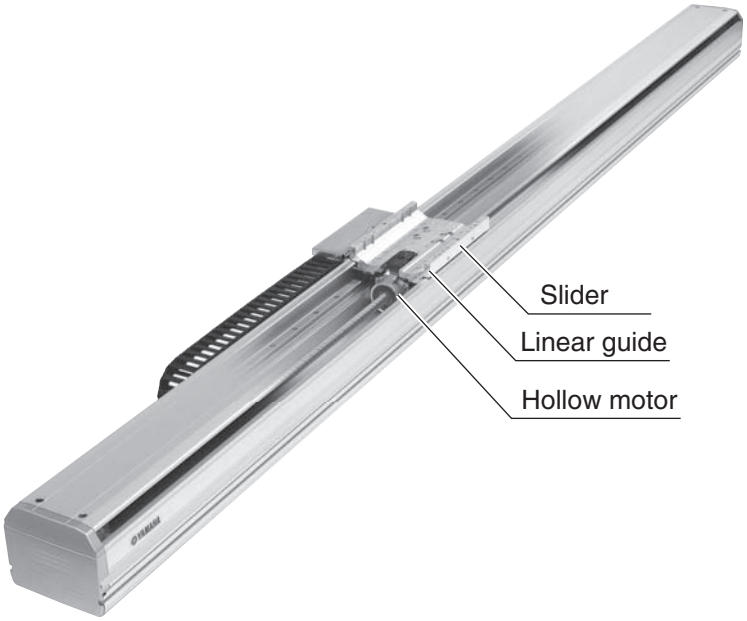

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Chapter 3 Installation and connections

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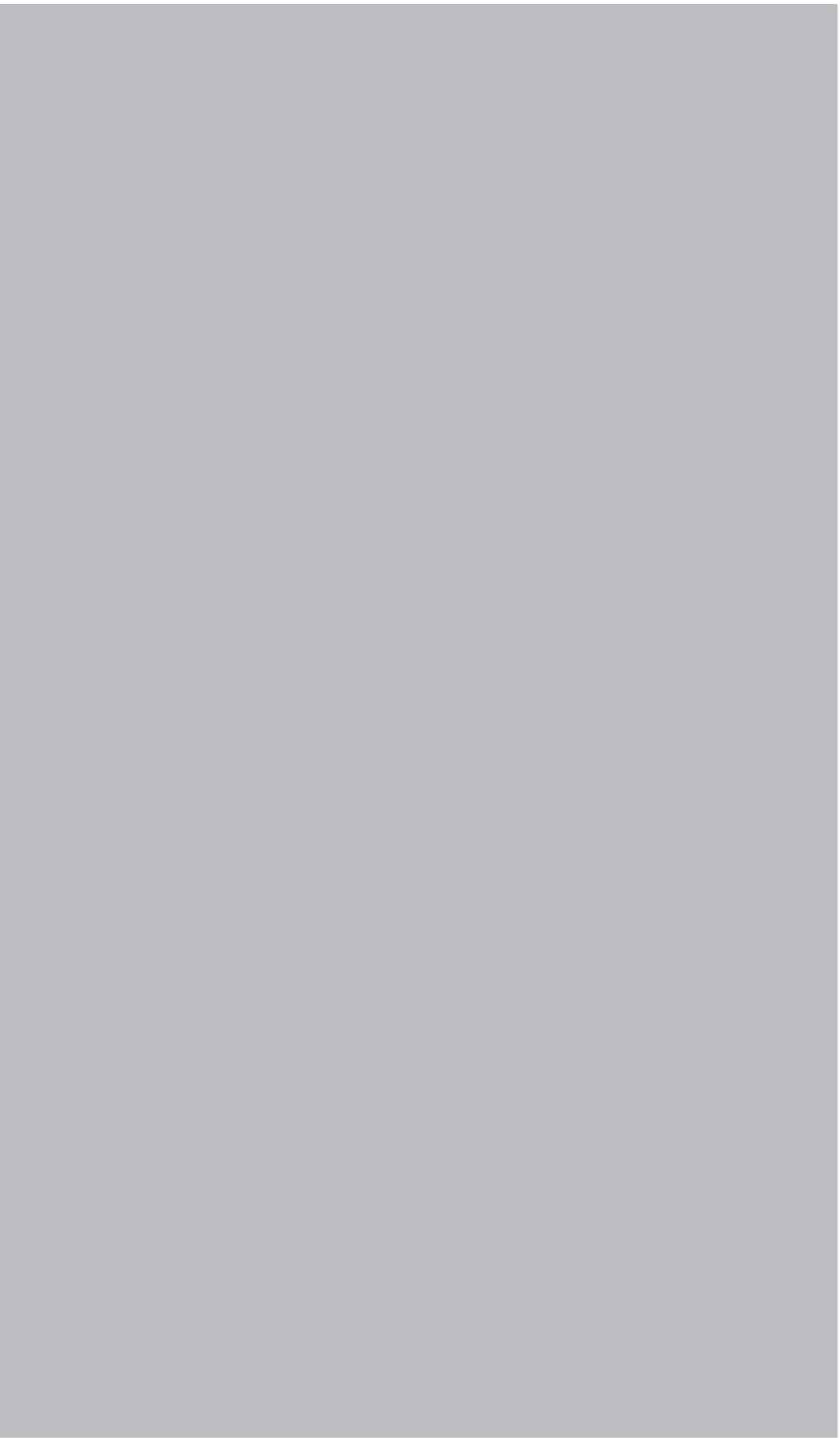


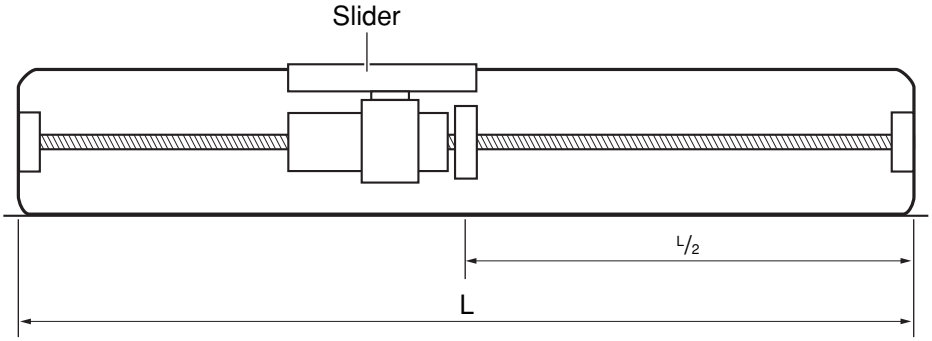
3-1 Carrying the robot

Always use two people to carry the robot unit. Each person should grip the robot unit near one end from the lower side and carry with the load well balanced. Carry with the robot facing upward (slider side upwards).

WARNING

ALWAYS OBSERVE THE FOLLOWING PRECAUTIONS WHEN CARRYING THE ROBOT.

- **REMOVE ANY AND ALL OBJECTS SUCH AS HANDS AND GRIPPERS ATTACHED TO THE ROBOT SLIDER BEFORE MOVING THE ROBOT. THE SLIDER WILL LOSE BALANCE IF MOVED WITH OBJECTS STILL ATTACHED AND CAUSE INJURIES.**
- **KEEP THE ROBOT BALANCED AND DON'T LET IT TILT WHILE MOVING IT. IF THE ROBOT TILTS, THE SLIDER MAY MOVE UNDER ITS OWN WEIGHT CAUSING SERIOUS INJURIES SUCH AS CRUSHED FINGERS.**
- **MOVE THE SLIDER SO THAT BALL NUT SECTION IS POSITIONED IN THE NEAR CENTER OF THE ROBOT BEFORE CARRYING THE ROBOT. FAILURE TO DO SO MAY CAUSE THE BALL SCREW TO SWING OR VIBRATE LARGELY WHILE CARRYING THE ROBOT.**



- **NEVER ATTEMPT TO HOLD THE ROBOT IN ANY OF THE FOLLOWING MANNERS.**

[Never try this when moving!]

- **DO NOT CARRY BY HOLDING THE SLIDER.**
- **DO NOT CARRY BY HOLDING THE CABLE.**
- **DO NOT CARRY BY HOLDING THE CABLE CARRIER.**
- **DO NOT CARRY BY GRIPPING THE END COVER.**
- **DO NOT CARRY BY HOLDING THE TOP COVER.**

3-2 Robot Installation Conditions

3-2-1 Installation environments

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	10 to 45°C
Allowable ambient humidity	35 to 85% RH (no condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust and liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge and radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For detailed information on how to install the robot controller, refer to the separate "YAMAHA Robot Controller User's Manual".

WARNING

AVOID INSTALLING THE ROBOT IN LOCATIONS WHERE THE AMBIENT CONDITIONS MAY EXCEED THE ALLOWABLE TEMPERATURE OR HUMIDITY, OR IN ENVIRONMENTS WHERE EXCESSIVE MOISTURE, CORROSIVE GASES, METALLIC POWDER OR DUST ARE GENERATED. MALFUNCTIONS, FAILURES OR SHORT CIRCUITS MAY OTHERWISE RESULT.

WARNING

- **THIS ROBOT WAS NOT DESIGNED FOR OPERATION IN ENVIRONMENTS WHERE INFLAMMABLE OR EXPLOSIVE SUBSTANCES ARE PRESENT.**
- **DO NOT USE THE ROBOT IN ENVIRONMENTS CONTAINING INFLAMMABLE GAS, DUST OR LIQUIDS.**
  EXPLOSIONS OR FIRE COULD OTHERWISE RESULT.

WARNING

AVOID USING THE ROBOT IN LOCATIONS SUBJECT TO ELECTROMAGNETIC INTERFERENCE, ELECTROSTATIC DISCHARGE OR RADIO FREQUENCY INTERFERENCE. MALFUNCTIONS MAY OTHERWISE OCCUR.

WARNING

DO NOT USE THE ROBOT IN LOCATIONS SUBJECT TO EXCESSIVE VIBRATION. ROBOT INSTALLATION BOLTS MAY OTHERWISE BECOME LOOSE CAUSING THE ROBOT TO FALL OVER.

3-2-2 Installation base

To mount the robot, use an installation base that satisfies the following conditions.

1) The installation base is subjected to a great deal of stress while the robot is in operation. Prepare a sufficiently rigid and stable installation base, taking into account the robot weight including the end effector (gripper) and workpiece.

WARNING

IF THE INSTALLATION BASE IS NOT SUFFICIENTLY RIGID AND STABLE, VIBRATION (RESONANCE) MAY OCCUR DURING OPERATION, CAUSING ADVERSE EFFECTS ON THE ROBOT WORK.

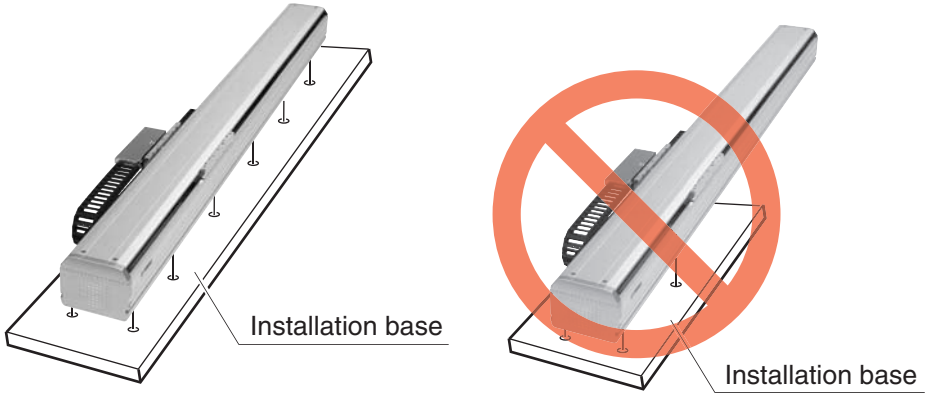
2) The installation base surface must be machined within a flatness of ±0.05mm/500mm.

CAUTION

The robot positioning accuracy or the service life might be reduced if the installation surface precision is insufficient.

3) Use an installation base of sufficient size to match the robot body so that the robot can be installed with the specified number of bolts. Avoid installing the robot with less than the specified number of bolts or installing the robot closer to one end as shown at the lower right.

Robot installation example



Good example　　Bad example

WARNING

WHEN INSTALLING THE ROBOT, ALWAYS USE ALL THE INSTALLTION HOLES OR M6 TAPPED HOLES IN THE BOTTOM OF THE ROBOT FRAME. USING LESS THAN THE SPECIFIED NUMBER OF BOLTS TO INSTALL THE ROBOT MAY CAUSE VIBRATION AND POOR POSITIONING ACCURACY. THIS MAY ALSO RESULT IN POSITIONING ERRORS AND REDUCED SERVICE LIFE IN THE WORST CASES.

NOTE

Positions of robot mounting holes differ according to the stroke length of each robot. Refer to the external view and dimensions for each robot model shown in the catalog or website (www.yamaha-motor.co.jp/global/industrial/robot).

3-3 Installing the robot

There are two methods for installing the robot.

Installation method A: Use this method for installing the N15.

Installation method B: Use this method for installing the N15/N18.

- **Installation method A (N15 only)**
  Drill holes through the installation base and secure the robot to the base with M6 bolts from below the base. (M6 tapped holes are already machined in the bottom of the robot frame.)
- **Installation method B (N15/N18)**
  Drill and tap M6 holes (for N15) or M8 holes (for N18) into the installation base and secure the robot to the base with M6 bolts (for N15) or M8 bolts (for N18) from above the robot frame.

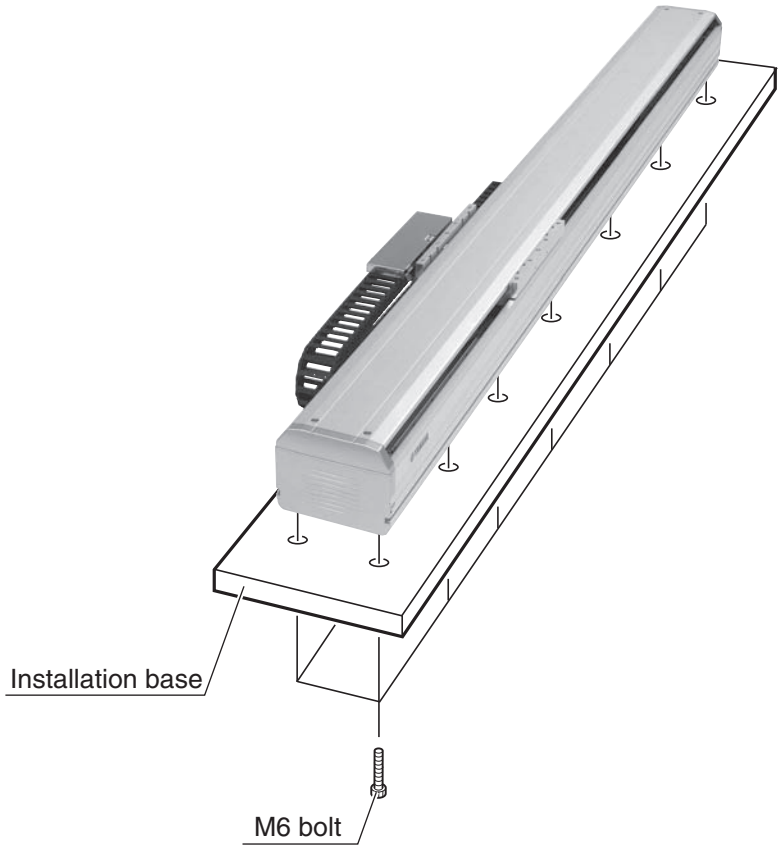
WARNING

- **BEFORE INSTALLING THE ROBOT, ALWAYS MAKE SURE THAT THE ROBOT CONTROLLER IS NOT CONNECTED TO THE ROBOT OR THE POWER TO THE CONTROLLER IS OFF. SERIOUS ACCIDENTS MAY OCCUR IF THE ROBOT STARTS TO OPERATE DURING INSTALLATION.**
- **BE SURE TO USE THE BOLTS OF THE SPECIFIED SIZE AND LENGTH AND TIGHTEN THEM SECURELY TO THE CORRECT TORQUE IN THE CORRECT POSITIONS. FAILURE TO FOLLOW THIS INSTRUCTION MAY CAUSE ROBOT VIBRATIONS, POSITION ERRORS AND SERIOUS ACCIDENTS.**
- **DO NOT USE A BOLT LONGER THAN THE SPECIFIED LENGTH SINCE IT MAY INTERFERE WITH THE INTERNAL PARTS OF THE ROBOT AND CAUSE MALFUNCTIONS.**

- **Installation method A (N15 only)**

  Drill holes through the installation base where the robot is secured. Then secure the robot to the base with specified bolts from below the base. For machining positions of the through holes, refer to the robot external view and dimensions shown in the catalog or website (www.yamaha-motor.co.jp/global/industrial/robot).
  The bolts and tightening torque are shown below.

	N15
Bolt	Hex socket-head M6 bolt, Strength: 8.8T Length: installation base thickness $+10^{+0}_{-2}$ mm
Tightening torque	9.8Nm to 12.7Nm (100kg • cm to 130kg • cm)

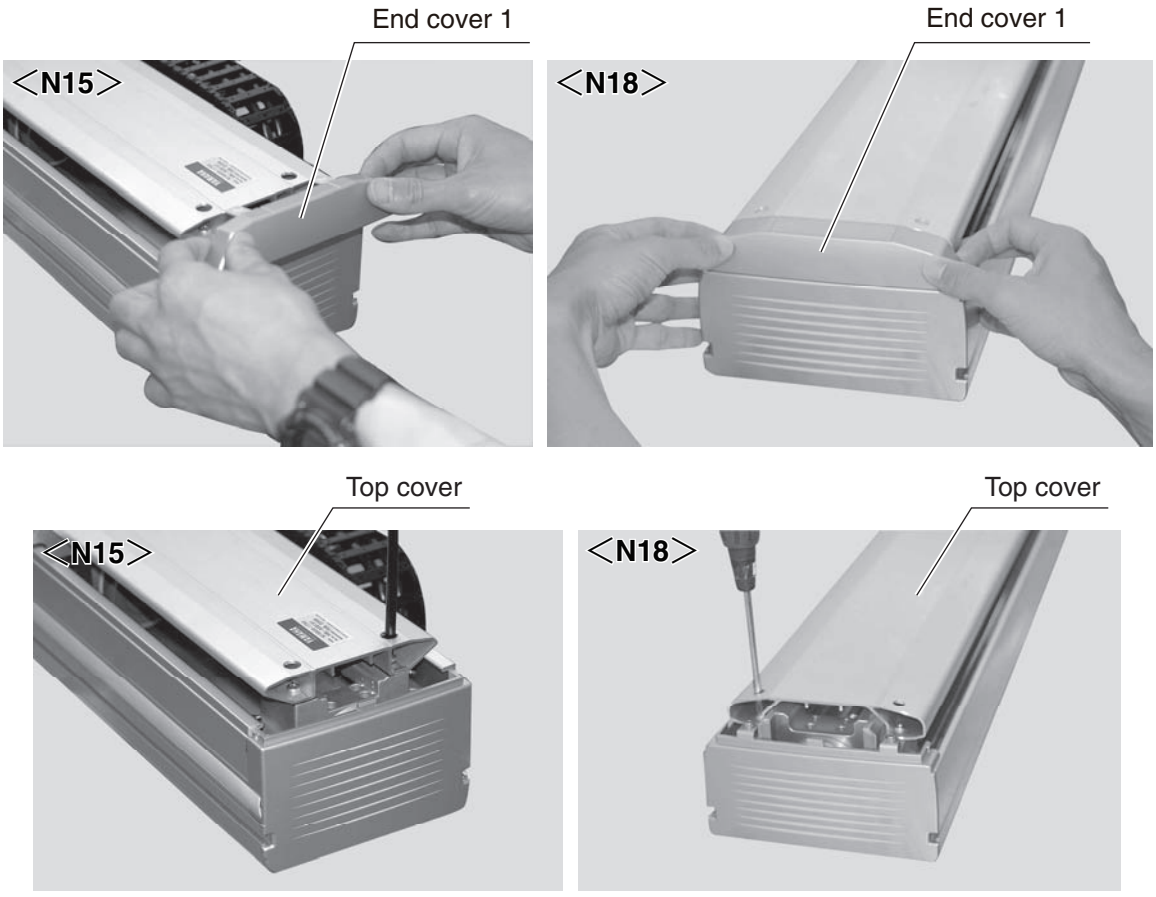


* Because the robot frame has a cavity inside the tapped holes, it is possible to use bolts whose length is up to the installation base thickness + 20mm. Even in this case, the length of the bolt thread engagement is 10mm.

- **Installation method B (N15/N18)**

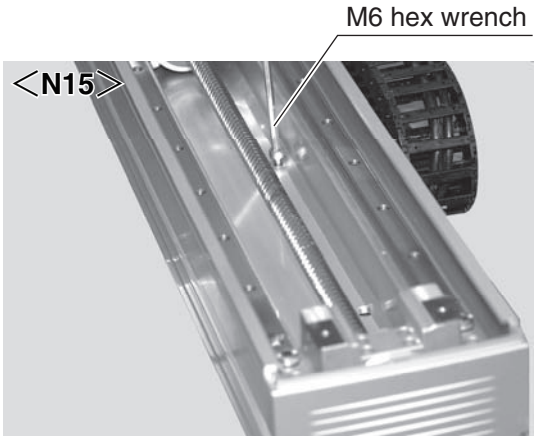
  Drill and tap M6 holes (for N15) or M8 holes (for N18) into the installation base. For machining positions of the tapped holes, refer to the robot external view and dimensions shown in the catalog or website (www.yamaha-motor.co.jp/global/industrial/robot). The bolt tightening method and torque are explained below.

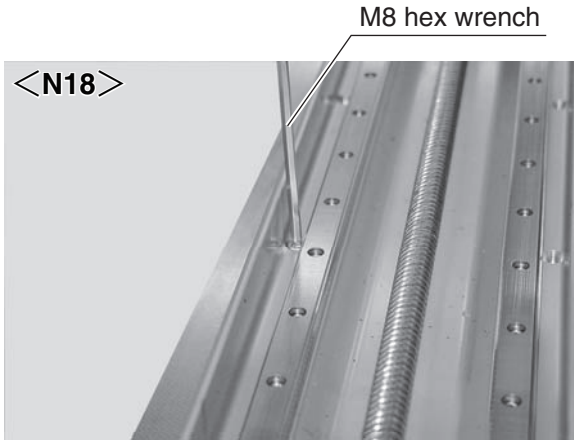
1) Remove the end cover 1 (upper end cover) from each end of the robot. Then remove the screws (total of 4) holding the top cover and remove the top cover.



2) Secure the robot to the base with the specified bolts utilizing the mounting holes in the bottom of the robot frame.
While moving the table slider, secure the robot to the base using all the mounting holes in the bottom of the robot frame.

	N15	N18
Bolt	Hex socket-head M6 bolt, Strength: 8.8T Length: 16mm or more	Hex socket-head M8 bolt, Strength: 8.8T Length: 50mm or more
Tightening torque	9.8Nm to 12.7Nm (100kg • cm to 130kg • cm)	22.5Nm to 36.7Nm (230kg • cm to 370kg • cm)





WARNING
TIGHTEN THE BOLTS SECURELY TO THE CORRECT TORQUE. FAILURE TO FOLLOW THIS INSTRUCTION MAY CAUSE POSITIONING ERRORS AND SERIOUS ACCIDENTS.

3) After installing the robot, reattach the top cover and end covers 1 (upper end covers).

3-4 Connecting the robot to the controller

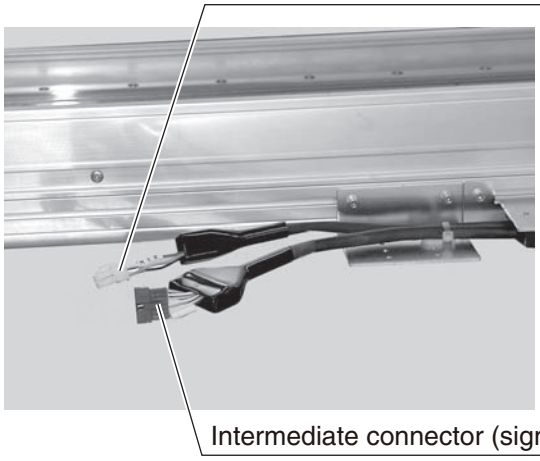
Connect the robot cables to the mating connectors on the controller as shown. Refer to the robot controller user's manual for the controller connectors.

WARNING

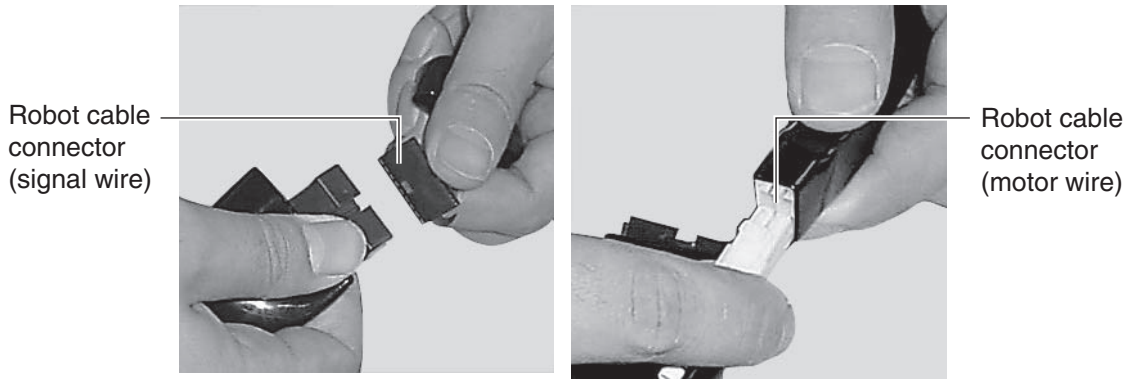
- **BEFORE CONNECTING THE CABLES, CHECK THAT THERE ARE NO BENDS OR BREAKS IN THE ROBOT CABLE CONNECTOR PINS AND THAT THE CABLES ARE NOT DAMAGED. CONTACT FAILURE MAY CAUSE ROBOT MALFUNCTIONS.**
- **ALWAYS MAKE SURE THAT THE POWER TO THE ROBOT CONTROLLER IS OFF BEFORE CONNECTING THE ROBOT CABLES TO THE CONTROLLER.**

CAUTION

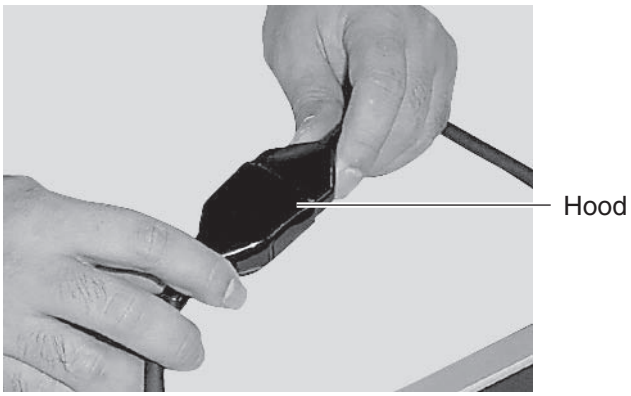
After connecting the robot cable intermediate connectors together, fit the connector hoods together securely.



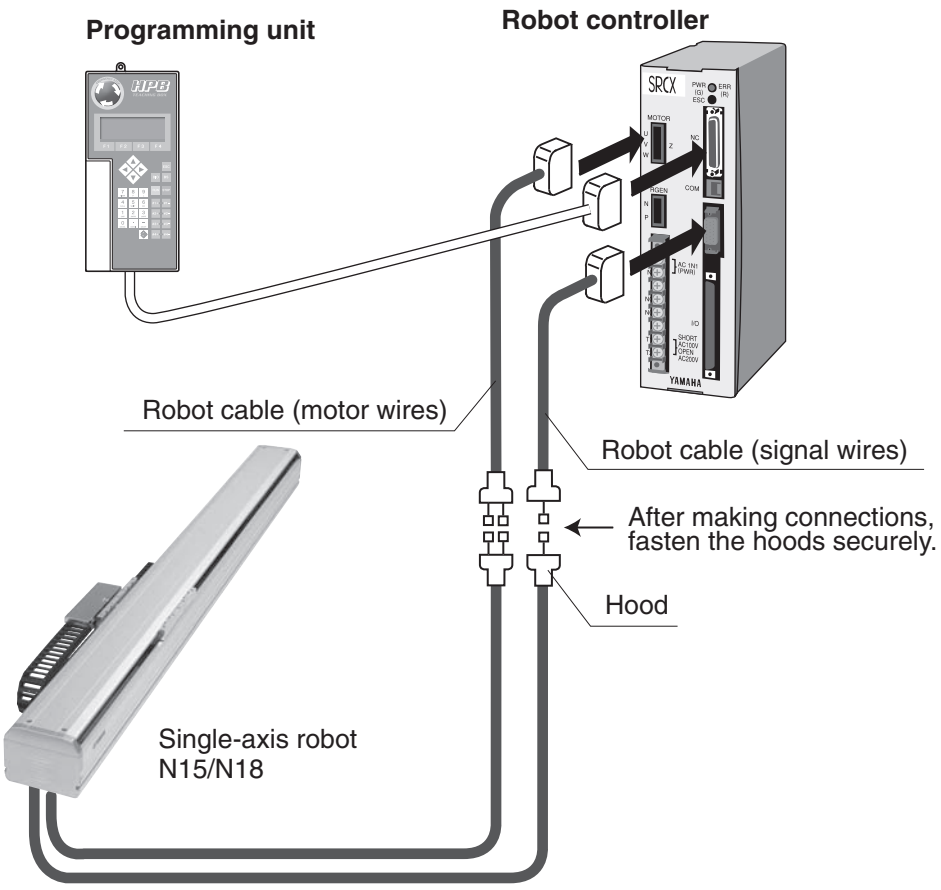
1) Connect the robot cables (motor and signal wires) to the mating connectors coming out from the robot.

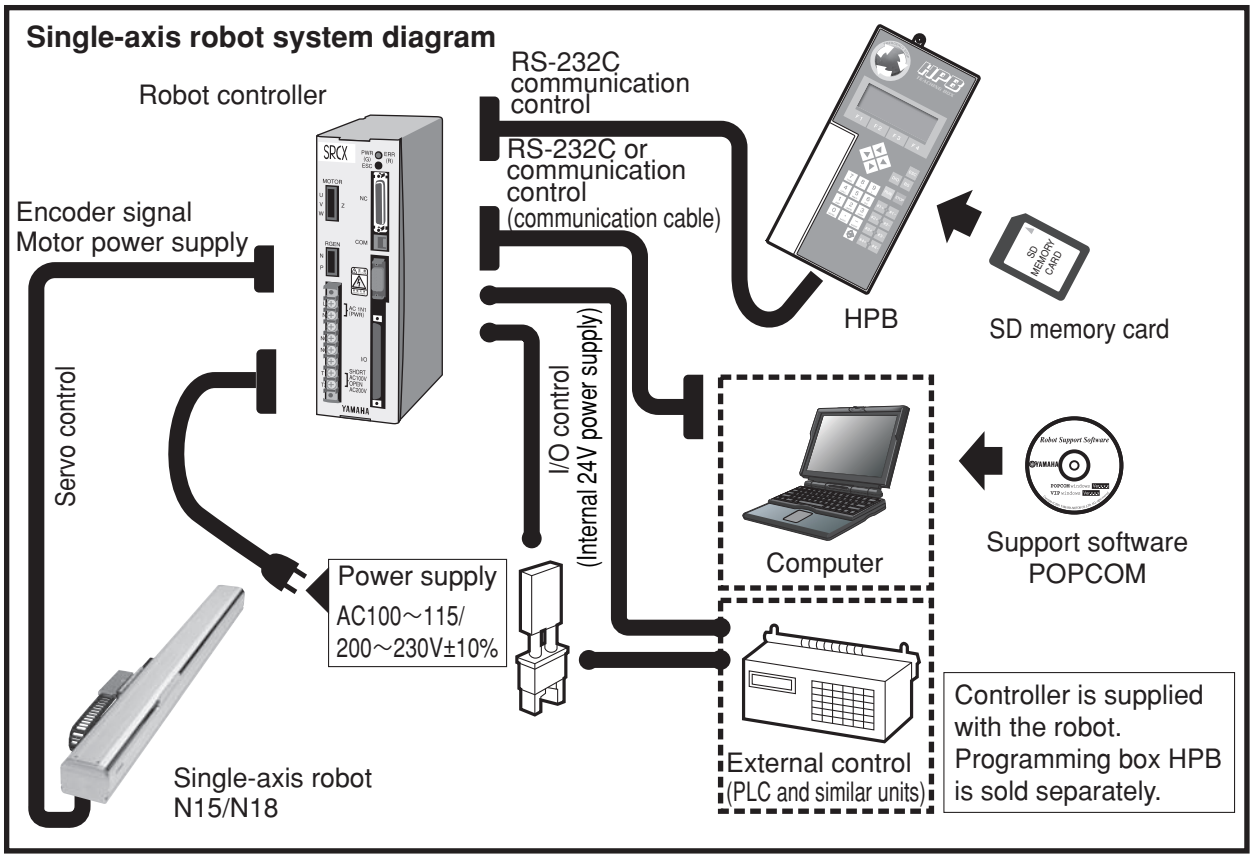


2) After making the connections, fit the connector hoods together securely.



■ Robot cable connections





3-5 Precautions during user wiring and hose installation

- **Cable carries (plastic chain for cable guide)**

  User cables and air hoses can be routed in the cable carrier of the N15/N18. Observe the following precautions when routing user cables and air hoses in the cable carrier.

CAUTION

- **The cable and air hoses should take up less than 30% of the space when storing them inside the cable carrier. Lay out the cables and air hoses in rows inside the cable carrier so they do not cross each other.**
- **The cables and air hoses inside the cable carrier will shift while the robot is operating, becoming taut and placing a strain on the connectors at both ends. To prevent this loosely fasten the cables and air hose to the cable carrier with cable ties to prevent strain from being applied. (Fasten them lightly since the cables and hoses might break if secured too tightly.)**
- **Do not remove or mount brackets installed on the cable carrier or attempt to modify them.**

Chapter 4 Periodic inspection and maintenance

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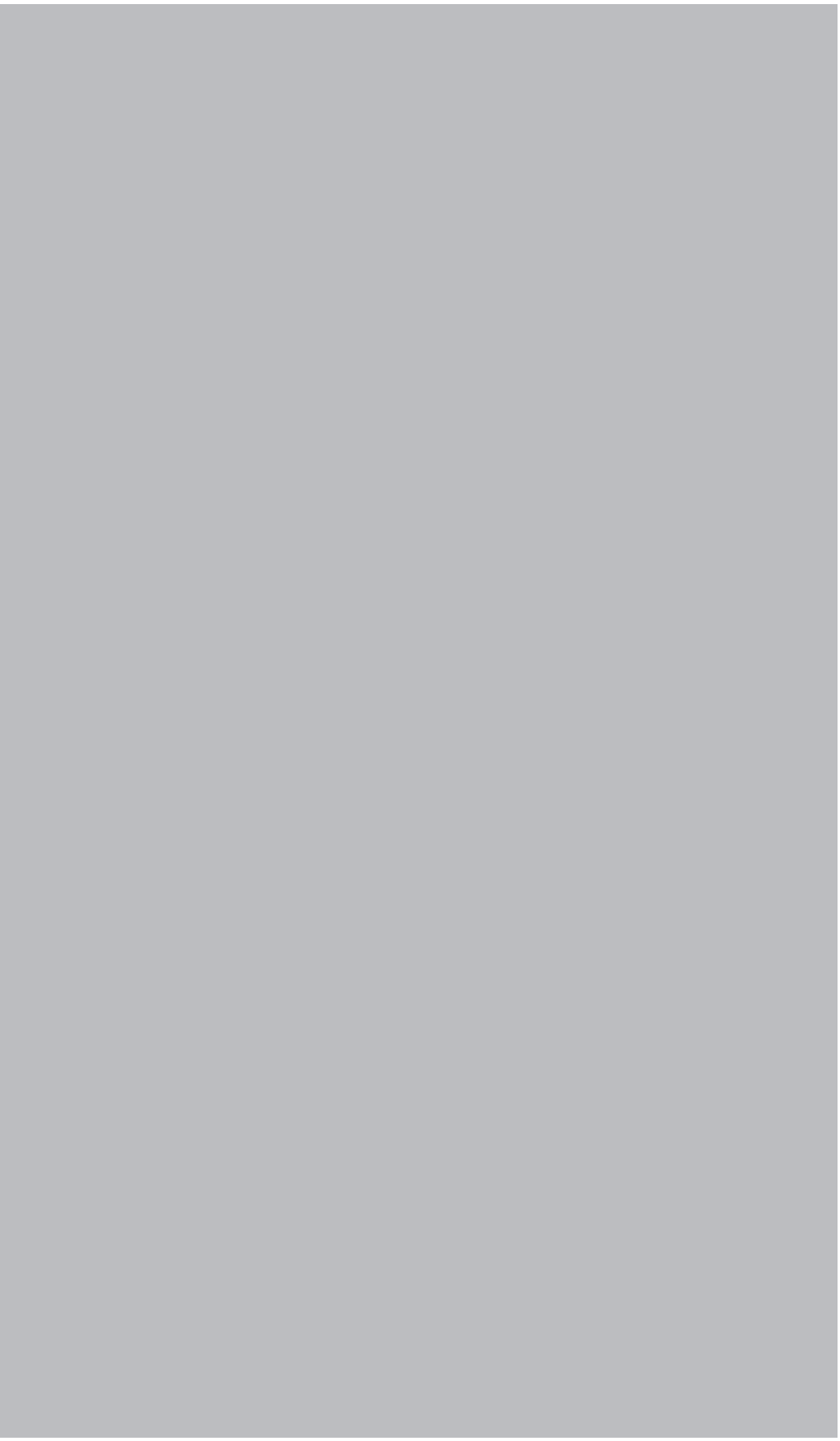


4-1 Before beginning work

Periodic inspection and maintenance are essential to ensure safe and efficient operation of YAMAHA robots. This chapter describes periodic inspection items and procedures for the N15/N18. Before beginning work, read the precautions below and also in Chapter 1 "Using the Robot Safely" and follow the instructions.

DANGER

IF THE INSPECTION OR MAINTENANCE PROCEDURE CALLS FOR OPERATION OF THE ROBOT, STAY OUT OF THE WORKING AREA OF THE ROBOT DURING OPERATION. DO NOT TOUCH ANY PARTS INSIDE THE CONTROLLER.
KEEP WATCHING THE ROBOT MOVEMENT AND SURROUNDING AREA SO THAT THE OPERATOR CAN PRESS THE EMERGENCY STOP BUTTON IF ANY DANGER OCCURS.

WARNING

- **WHEN THE ROBOT DOES NOT NEED TO BE OPERATED DURING ADJUSTMENT OR MAINTENANCE, ALWAYS TURN OFF THE CONTROLLER AND THE EXTERNAL SWITCH BOARD.**
- **DO NOT TOUCH INTERNAL PARTS OF THE CONTROLLER FOR 5 SECONDS AFTER THE CONTROLLER HAS BEEN TURNED OFF.**
- **WHEN ONLY MAKING ELECTRICAL INSPECTIONS AND REQUIRING NO MECHANICAL MOVEMENT OF THE ROBOT, KEEP THE EMERGENCY STOP BUTTON PRESSED.**
- **USE ONLY LUBRICANT AND GREASES SPECIFIED BY YAMAHA SALES OFFICE OR REPRESENTATIVE.**
- **USE ONLY PARTS SPECIFIED BY YAMAHA SALES OFFICE OR REPRESENTATIVE. TAKE SUFFICIENT CARE NOT TO ALLOW ANY FOREIGN MATTER TO CONTAMINATE THEM DURING ADJUSTMENT, PARTS REPLACEMENT OR REASSEMBLY.**
- **DO NOT MODIFY ANY PARTS ON THE ROBOT OR CONTROLLER. MODIFICATION MAY RESULT IN UNSATISFACTORY SPECIFICATIONS OR THREATEN OPERATOR SAFETY.**
- **WHEN ADJUSTMENT OR MAINTENANCE IS COMPLETE, RETIGHTEN THE BOLTS AND SCREWS SECURELY.**
- **DURING ROBOT ADJUSTMENT OR MAINTENANCE, PLACE A SIGN INDICATING THAT THE ROBOT IS BEING ADJUSTED OR SERVICED TO PREVENT OTHERS FROM TOUCHING THE CONTROL KEYS OR SWITCHES. PROVIDE A LOCK ON THE SWITCH KEYS OR ASK SOMEONE TO KEEP WATCH AS NEEDED.**

When applying grease to the ball screw and linear guide, take the following precautions.

WARNING

PRECAUTIONS WHEN HANDLING GREASE:

- **INFLAMMATION MAY OCCUR IF THIS GETS IN THE EYES. BEFORE HANDLING THE GREASE, WEAR YOUR SAFETY GOGGLES TO ENSURE THE GREASE WILL NOT COME IN CONTACT WITH THE EYES.**
- **INFLAMMATION MAY OCCUR IF THE GREASE COMES INTO CONTACT WITH SKIN. BE SURE TO WEAR PROTECTIVE GLOVES TO PREVENT CONTACT WITH SKIN.**
- **DO NOT TAKE ORALLY OR EAT. (EATING WILL CAUSE DIARRHEA AND VOMITING.)**
- **HANDS AND FINGERS MIGHT BE CUT WHEN OPENING THE GREASE CONTAINER, SO USE PROTECTIVE GLOVES.**
- **KEEP OUT OF THE REACH OF CHILDREN.**
- **DO NOT HEAT THE GREASE OR PLACE NEAR AN OPEN FLAME SINCE THIS COULD LEAD TO SPARKS AND FIRES.**

EMERGENCY TREATMENT:

- **IF GREASE GETS IN THE EYES, WASH LIBERALLY WITH PURE WATER FOR ABOUT 15 MINUTES AND CONSULT A PHYSICIAN FOR TREATMENT.**
- **IF GREASE COMES IN CONTACT WITH THE SKIN, WASH AWAY COMPLETELY WITH SOAP AND WATER.**
- **IF TAKEN INTERNALLY, DO NOT INDUCE VOMITING BUT PROMPTLY CONSULT A PHYSICIAN FOR PROPER TREATMENT.**

4-2 Periodic inspection

4-2-1 Daily inspection

Check the following points on a daily basis, before and after robot operation.

Checkpoints	Check items	Notes
Cables	Check for damage, dent and excessively tight bends.	Replace if needed.
Ball screw, bearing	Check for unusual vibration and noise.	
Motor	Check for unusual vibration and noise, and for abnormal temperature rise.	

4-2-2 Three-month inspection

Check the following points every 3 months and apply grease if needed.

Checkpoints	Check items	Notes
Ball screw, linear guide, ball bushing	• Check for dust buildup or debris. Clean if necessary. Apply grease after cleaning. • Check to see if the ball screw, linear guide and ball bushing are lubricated (not dry). Apply grease if necessary. Standard robots: Albania No. 2 (Shell) Daphne Eponex No. 2 (Idemitsu) Clean room robots: LG-2 (NSK)	See "4-3" in this chapter.

CAUTION

Using grease other than those recommended by YAMAHA might shorten the service life of the ball screw, linear guide and linear bushing shaft.

4-2-3 Six-month inspection

Check the following points every 6 months and adjust or replace parts if needed.

Checkpoints	Check items	Notes
Major bolts and screws on robot	Check for looseness. Tighten if loose.	
Ball screw, linear guide	• Check the ball screw and linear guide for backlash. Tighten if necessary. • Check for vibration during operation. Tighten bolts if necessary to secure drive unit and/or shaft. • Check for backlash due to wear.	Consult us if problem cannot be solved or there is backlash due to wear.
Controller	• Check if terminals are loose. • Check if connectors are loose	
Greasing to ball screw/nut section and linear guide	Apply grease every 6 months to ball screw/nut and linear guide. Recommended grease Albania No. 2 (Shell) Daphne Eponex No. 2 (Idemitsu)	See "4-3" in this chapter.
Slider	On long-stroke robots, check the slider inside the top cover for wear or damage every 6 months.	

CAUTION

Using grease other than those recommended by YAMAHA might shorten the service life of the ball screw and linear guide.

4-2-4 Three-year inspection

Check the following points every 3 years or more often if the robot is used frequently.

Checkpoints	Check items	Notes
Ball screw/nut section and linear guide	Check ball screw/nut and linear guide for backlash due to wear.	Consult us if abnormal condition is found.

4-3 Applying grease

When applying grease to the ball screw according to periodic inspection, follow the procedure below. Grease can be applied to the ball screw nut section using the grease nipples. Prepare a grease gun in this case.

1) Make sure that the power to the controller is off.

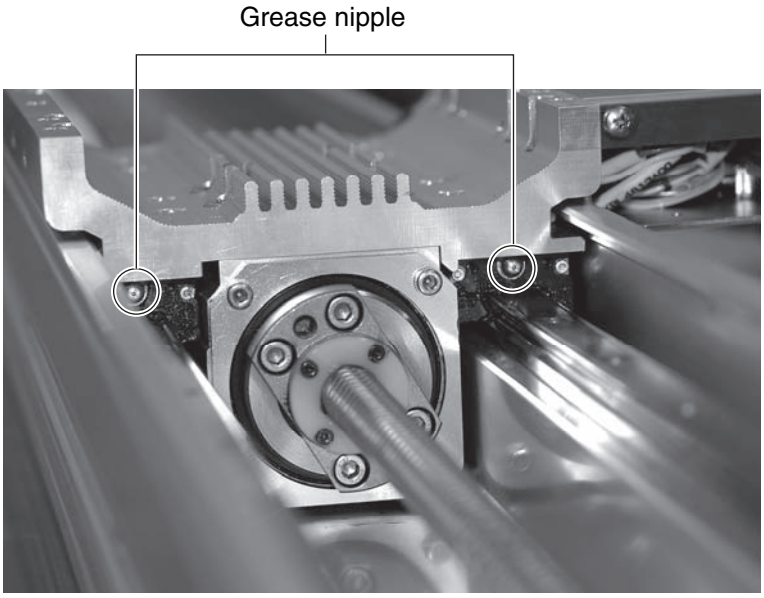
2) Remove the end covers 1 (upper end covers) from both ends of the robot.
Refer to "3-3 Installation method B" for how to remove the end covers.

3) Remove the screws holding the top cover and remove the top cover.
Refer to "3-3 Installation method B" for how to remove the end covers.

4) Apply grease by either of the following methods.

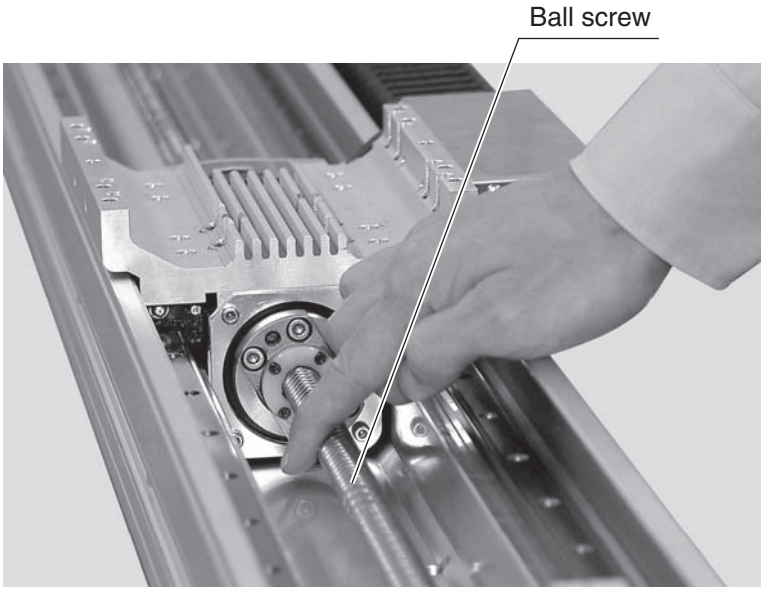
Linear guide:

When using a grease gun, apply grease into the four grease nipples (two each on both sides of the ball guide bearing. Then move the table slider back and forth to help spread the grease around.



Ball screw:

Apply grease by hand to the ball screw and move the table slider back and forth to help spread the grease around.

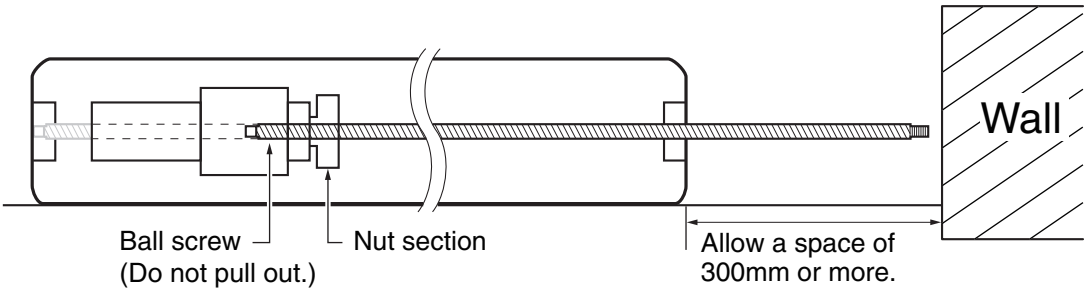


5) Reattach the top cover and end covers.

4-4 Replacing the motor

CAUTION

A positional shift occurs by replacing the motor. It is therefore necessary to perform return-to-origin and set point data again after replacing the motor. When removing the parts, note their positional relation and assembly order. Provide a space of at least 300mm between each end of the robot and the wall. Do not pull out the ball screw nut section from the ball screw.

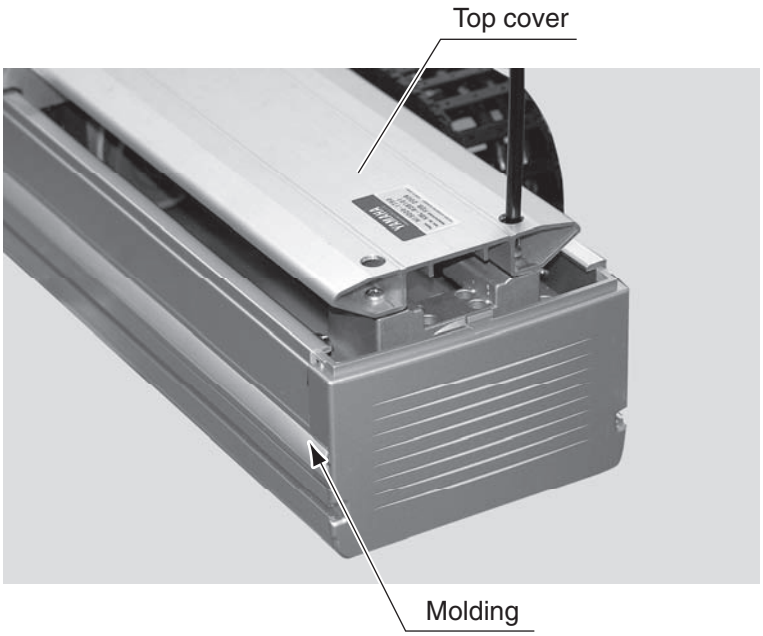


1) Turn off the controller power.

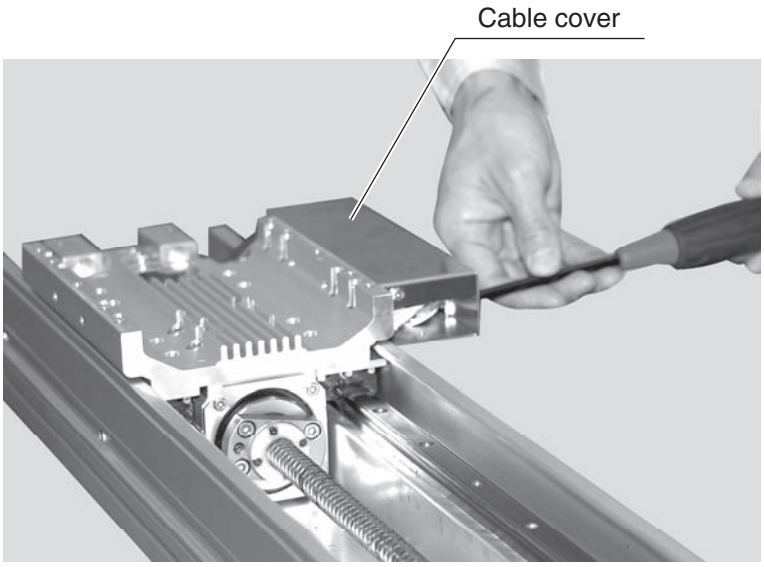
2) Remove the end covers 1 (upper end covers) from both ends of the robot.
Refer to "3-3 Installation method B" for how to remove the end covers.

3) Remove the top cover.
Remove the screws (4 places) holding the top cover and remove the top cover.

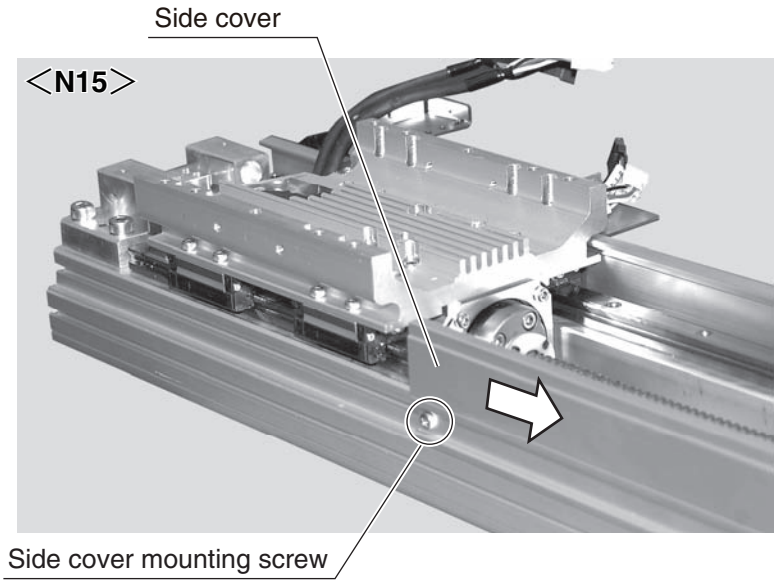
4) Remove the end covers 2 (lower end covers) from both ends of the robot.
Remove the screws (2 places) holding each end cover and remove the end covers.
(On the N15 robot, first remove the side moldings and then remove the screws holding each end cover. The end cover will come off.)



5) Remove the cable cover.
After removing the cable cover, cut the cable tie securing the motor cable with a wire cutter or scissors, and then disconnect the motor wire and signal wire connectors.

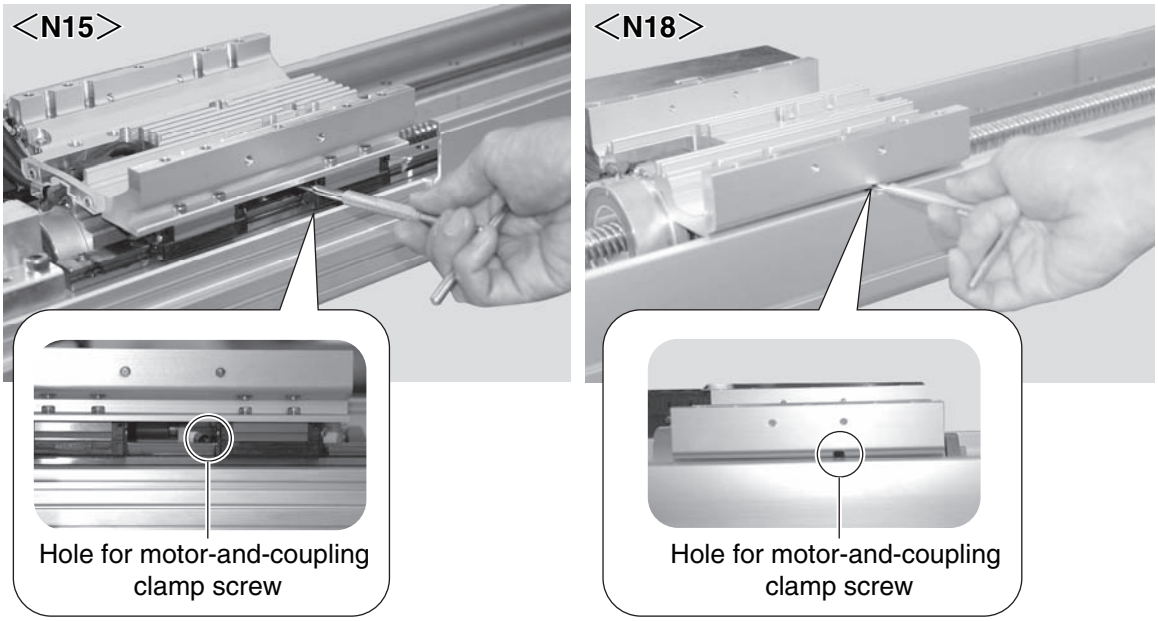


6) Loosen the screw securing the side cover and slide the side cover in the direction of arrow to a position that allows access to the motor unit.
(The N18 robot has no side cover, so skip this step.)

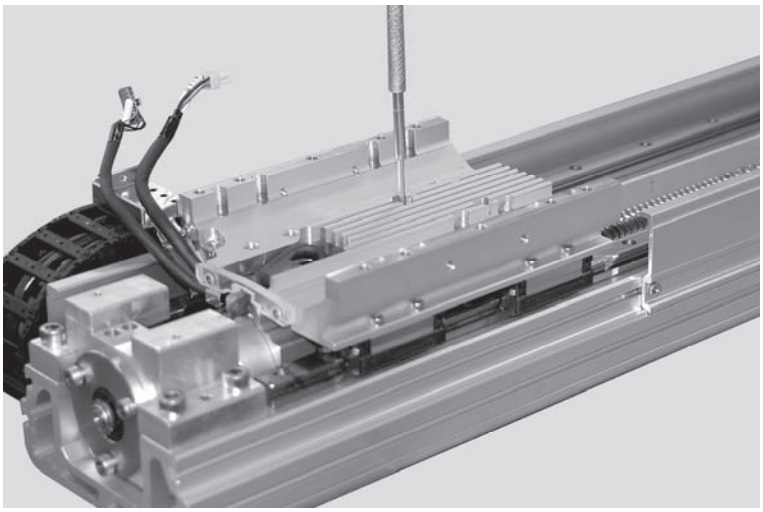


7) Free the table slider and motor coupling by loosening the screw that clamps the coupling to the motor shaft as shown below.

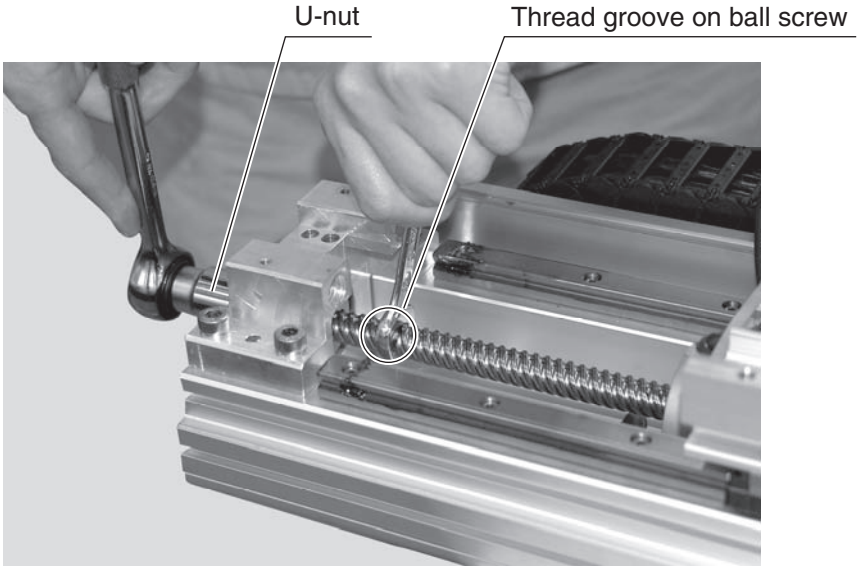
- **When workpiece is on table slider**



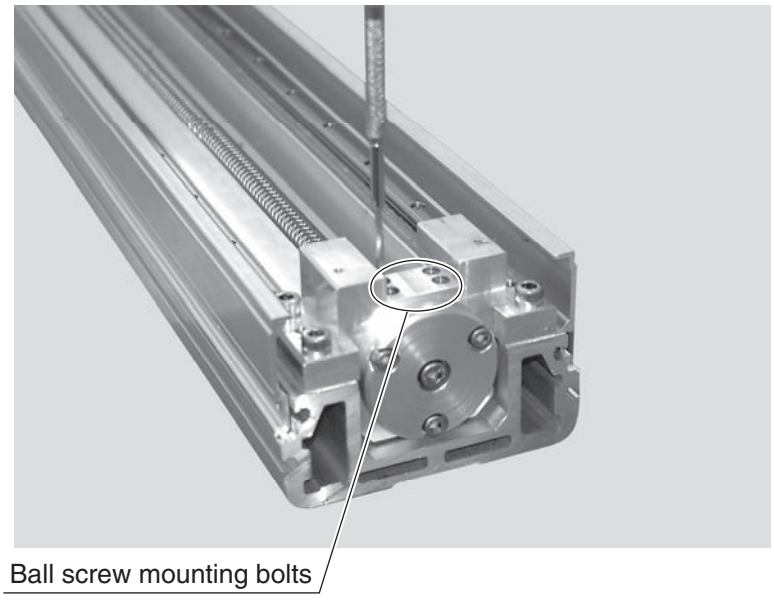
- **When no workpiece is on table slider**



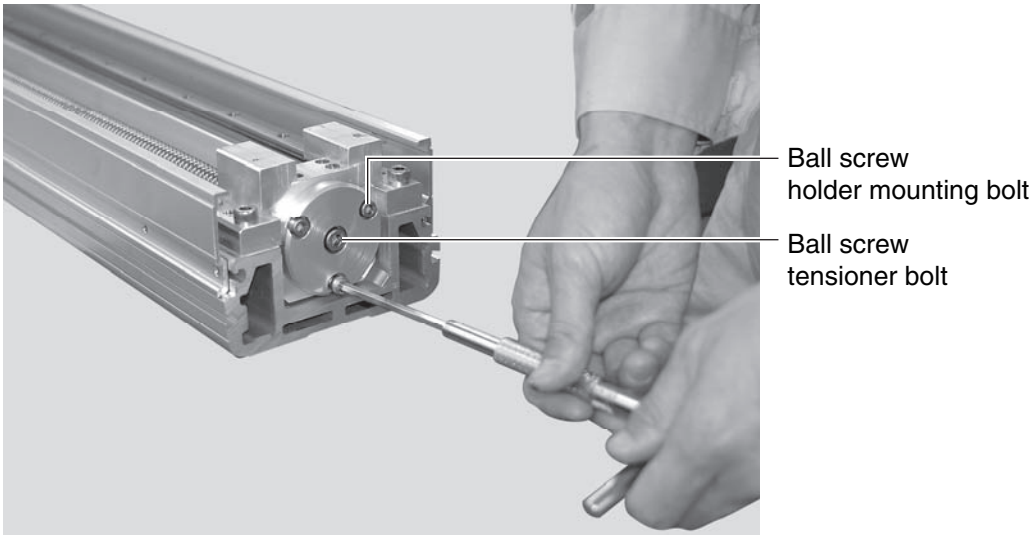
8) While holding the ball screw shaft with a wrench by placing it to the thread groove, loosen and remove the U-nut and washer.



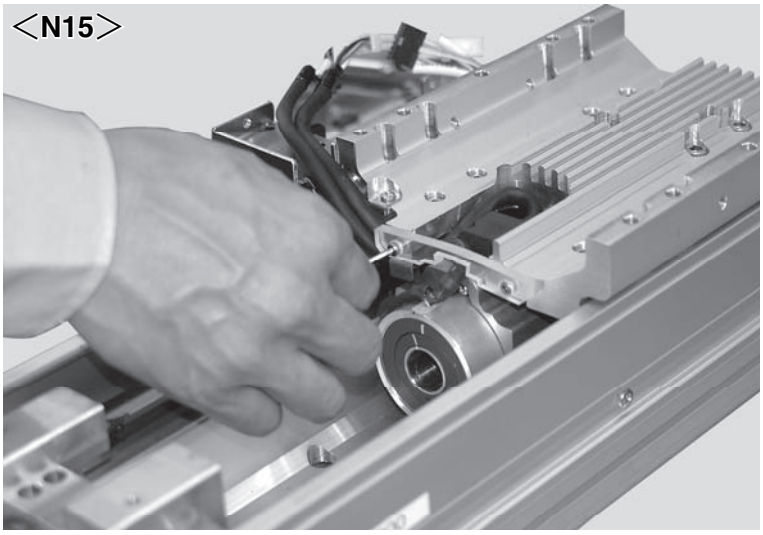
9) Loosen the mounting bolts (4 places) at the other end of the ball screw.



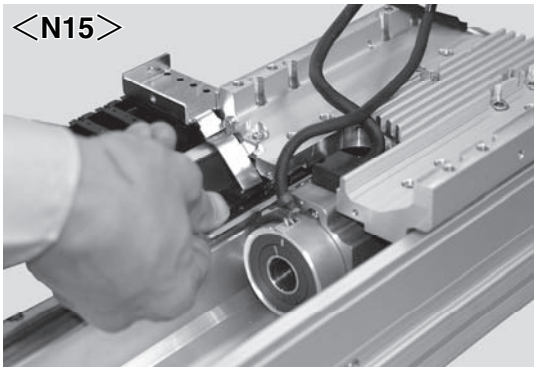
10) Remove the bolts (3 places) securing the ball screw holder and then remove the ball screw tensioner bolt (1 place).

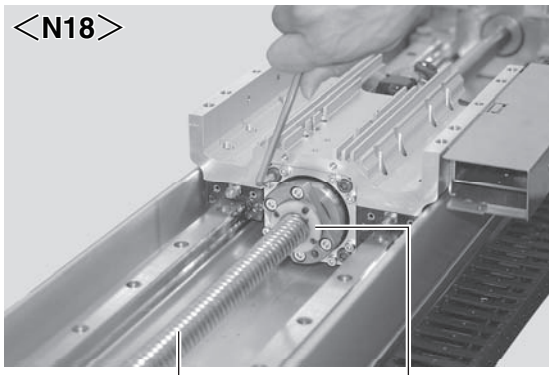


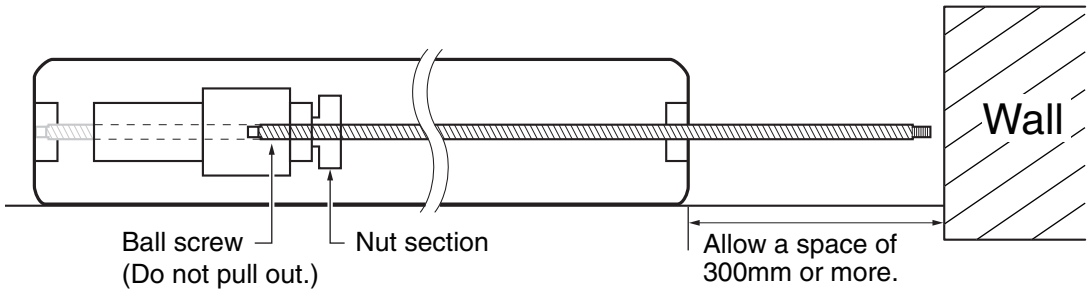
11) Remove the screws (2 places) securing the damper.
Skip this step for the N18 robot.



12) Remove the bolts (4 places) securing the motor and remove the motor. At this time, be careful not to allow the ball screw shaft to come out of the nut.







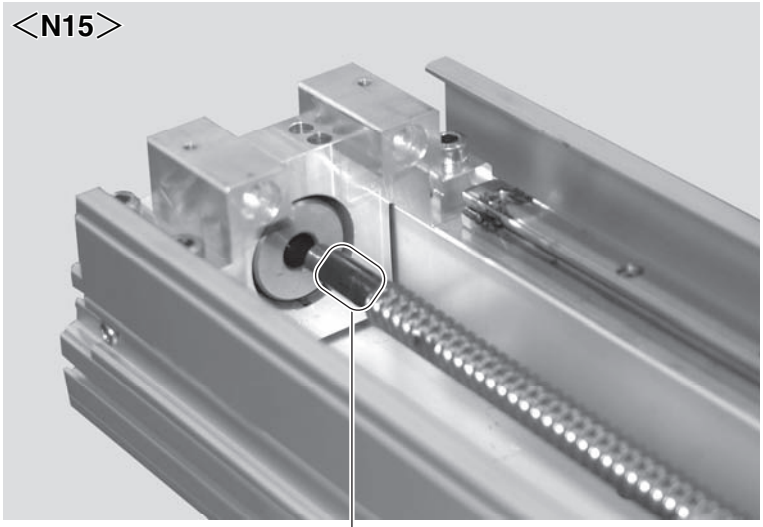
13) Install a new motor. Tighten the bolts to the following torque.

	N15	N18
Bolt	M5	M6
Tightening torque	60kg • cm to 90kg • cm	100kg • cm to 130kg • cm

14) Assemble in the reverse order of disassembly. Proceed while making sure the positional relation and assembly order of the parts are correct.

CAUTION

When installing the ball screw, apply the proper amount of molybdenum grease to the clamp portion (see photo below).



Apply molybdenum grease here.

15) After replacing the motor, adjust the coupling position so that the grid position is within 50±20%, which is displayed by performing return-to-origin.

- **Checking the grid position**

1) Press F2 (OPRT) on the initial screen.

```
[MENU]
select menu

1EDIT2OPRT3SYS 4MON
```

2) Press F1 (ORG).

```
[OPRT]
select menu

1ORG 2STEP3AUTO
```

3) Press F1 (YES) to perform return-to-origin.
If you want to cancel return-to-origin, press F2 (NO).

```
[OPRT-ORG-SEARCH]
ORG search OK ?

1YES 2NO
```

4) The screen on the right appears during return-to-origin.
If you want to interrupt return-to-origin before completed, press STOP .
The robot will stop and a message will appear. Then pressing ESC will return to the screen in step 2.

```
[OPRT-ORG-SEARCH]
searching ...
```

5) When return-to-origin is complete, the machine reference value is displayed on the bottom right of the screen.

```
[OPRT-ORG-SEARCH]
origin complete

grid position     50%
```

6) Press BS to display the grid position.

Chapter 5 Troubleshooting

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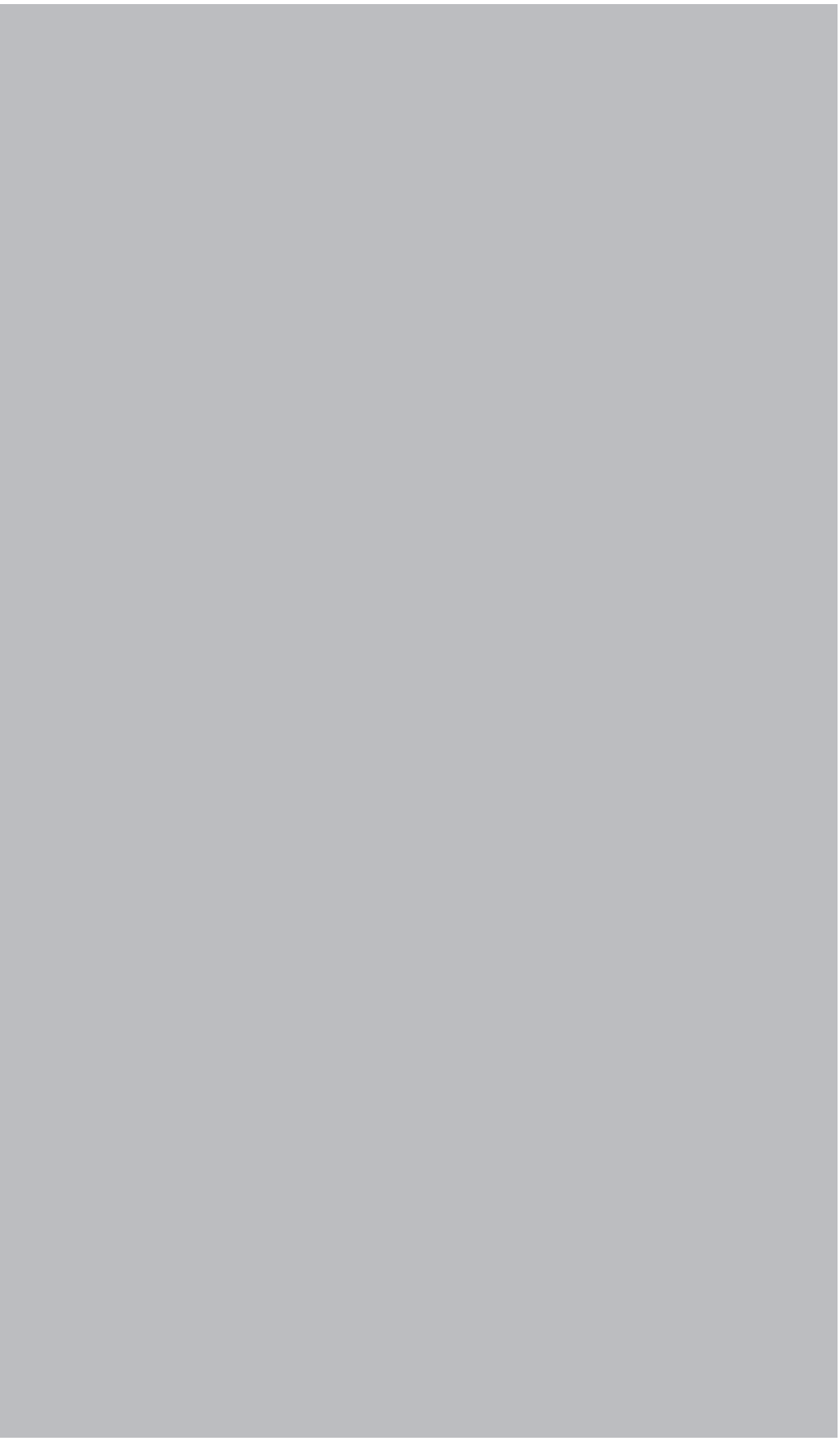
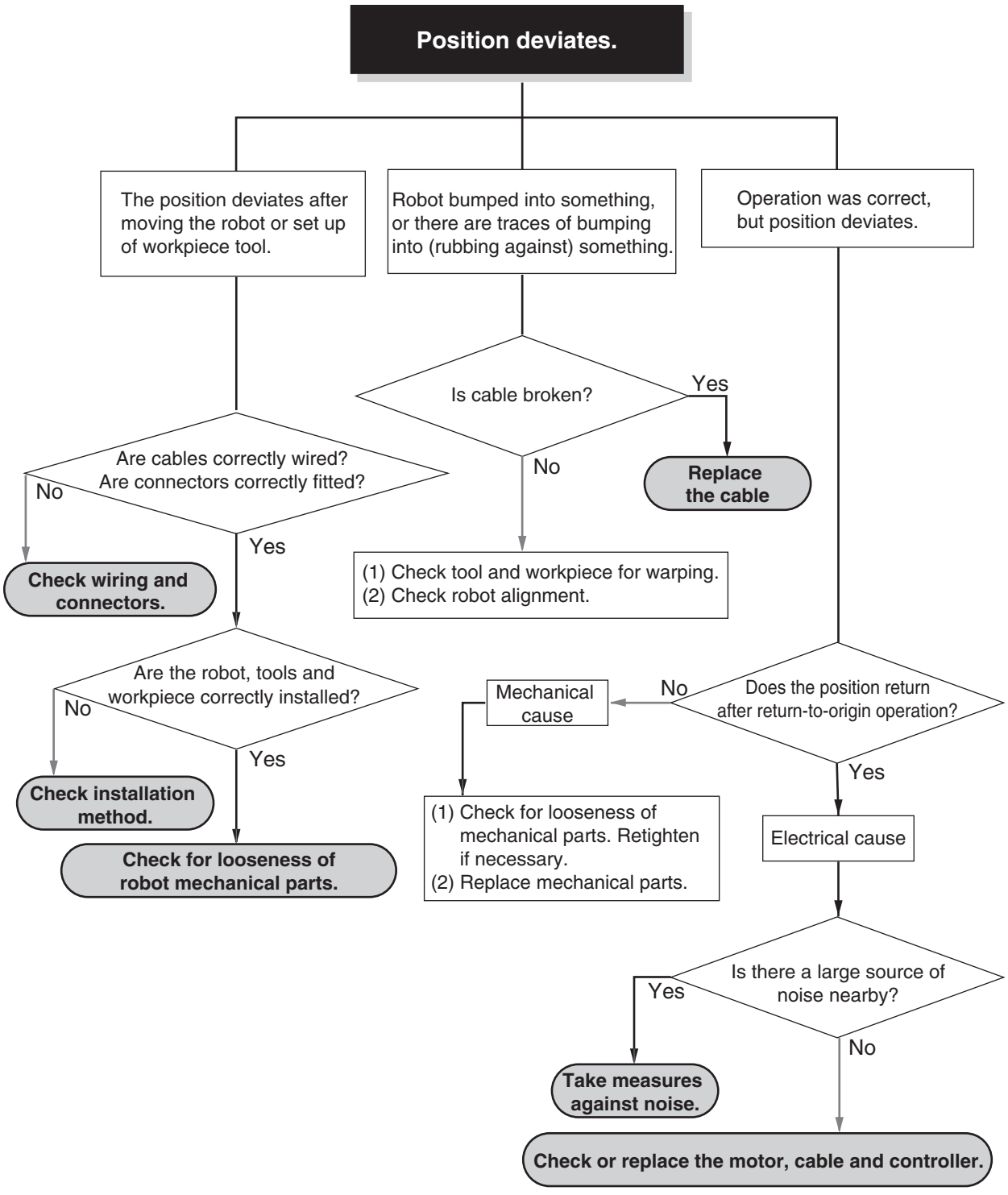
5-1-2 Feedback error 5-2



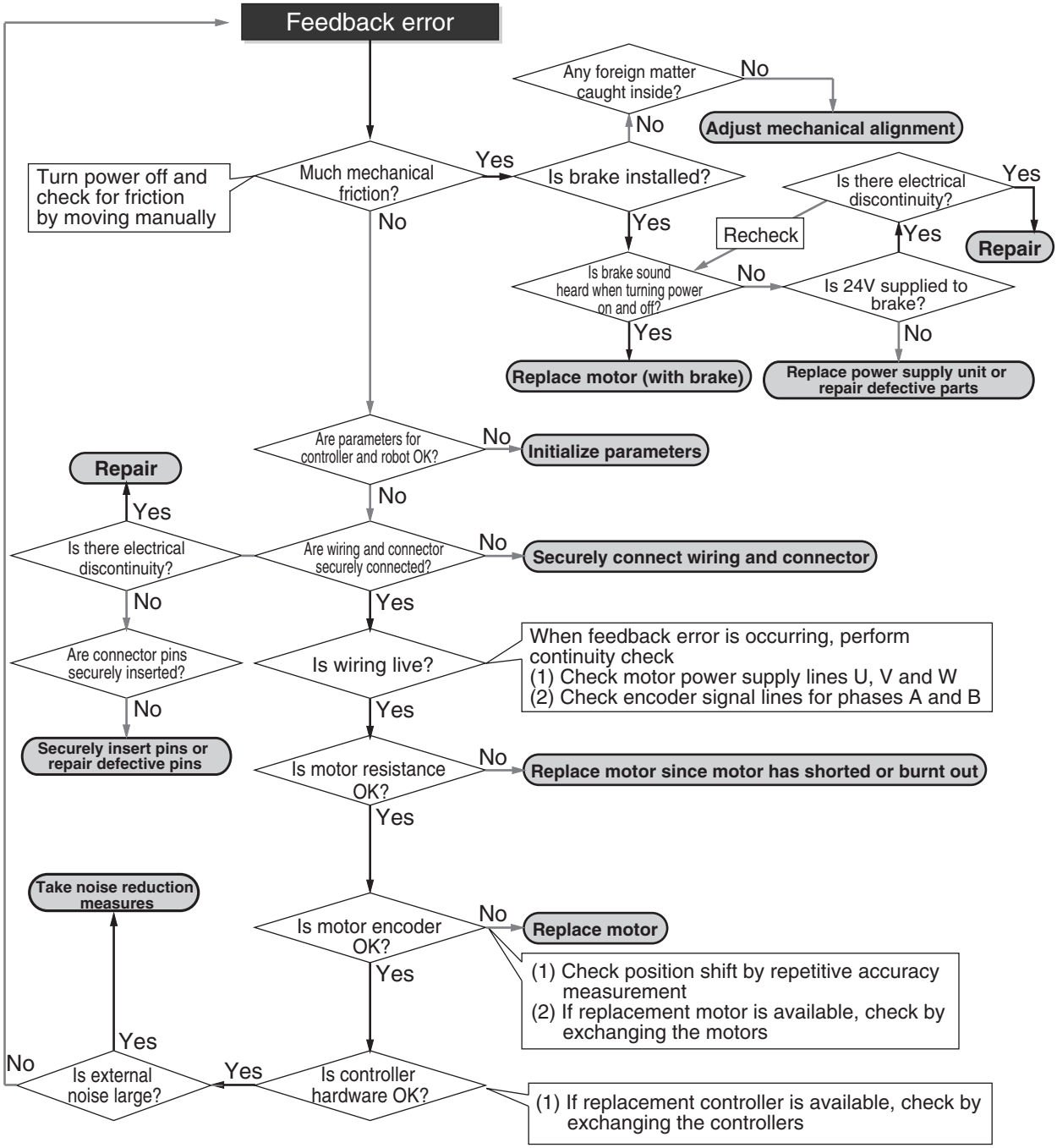
5-1 If you suspect trouble

If an error such as a positioning error or feedback error occurs, check the following points to find the solution before you determine the robot or controller has malfunctioned. If the trouble still exists even after checking these points, please contact us with a detailed description of the trouble.

5-1-1 Positioning error


Position deviates.
The position deviates after moving the robot or set up of workpiece tool.
Robot bumped into something, or there are traces of bumping into (rubbing against) something.
Operation was correct, but position deviates.
Is cable broken?
Yes
No
Replace the cable
Are cables correctly wired?
Are connectors correctly fitted?
No
Yes
Check wiring and connectors.
(1) Check tool and workpiece for warping.
(2) Check robot alignment.
Are the robot, tools and workpiece correctly installed?
No
Yes
Check installation method.
Check for looseness of robot mechanical parts.
Mechanical cause
No
Does the position return after return-to-origin operation?
Yes
(1) Check for looseness of mechanical parts. Retighten if necessary.
(2) Replace mechanical parts.
Electrical cause
Is there a large source of noise nearby?
Yes
No
Take measures against noise.
Check or replace the motor, cable and controller.

5-1-2 Feedback error



Chapter 6 Specifications

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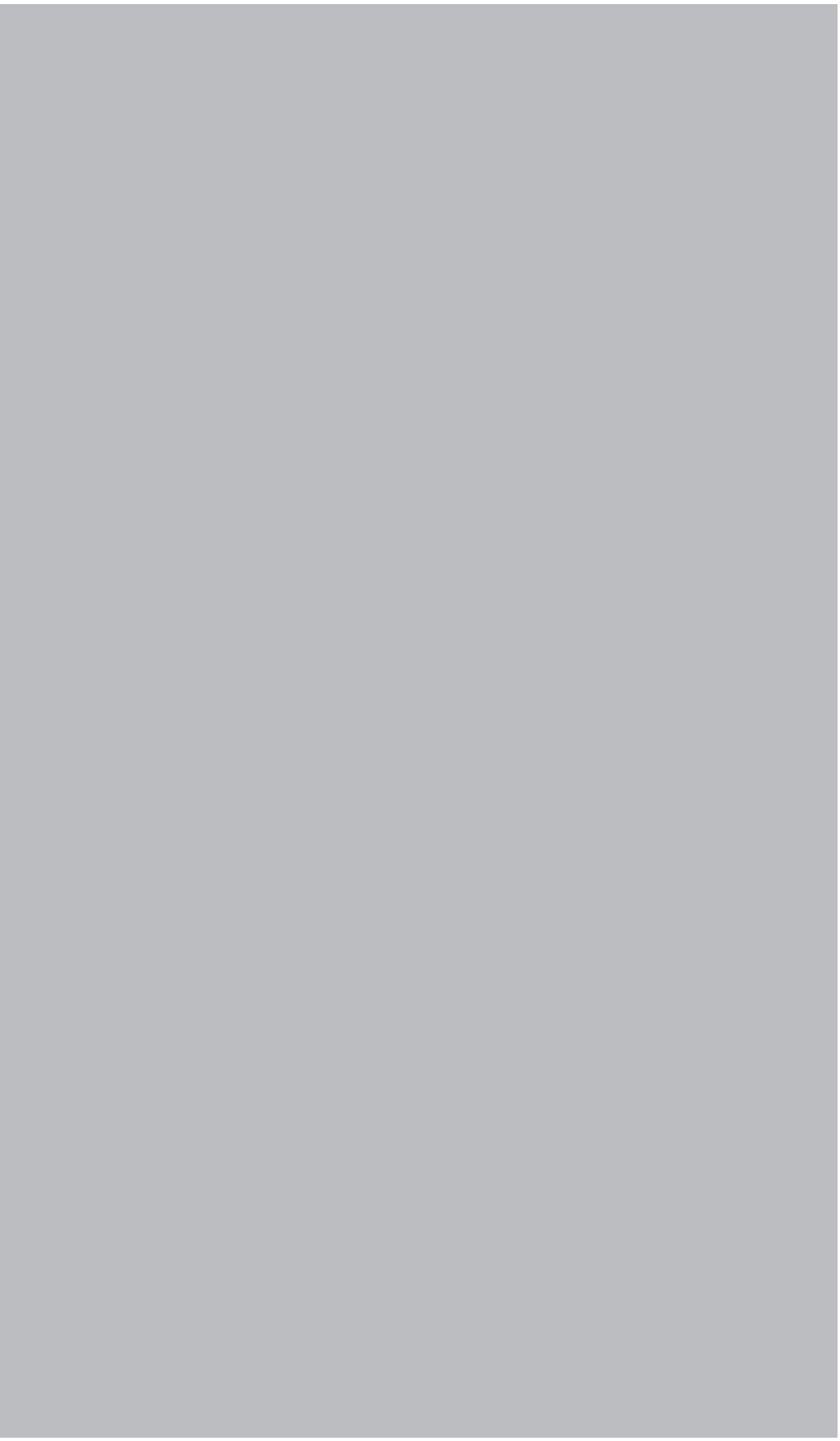


6-1 Main unit specifications

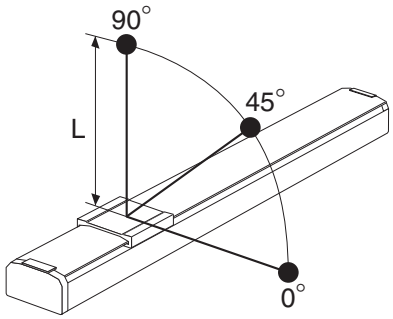
● N15 specifications

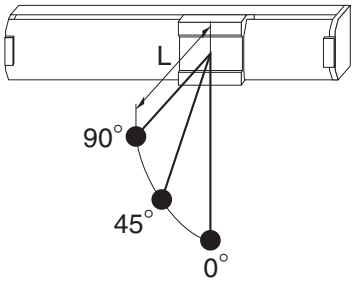
■ Basic specifications

Motor output AC (W)		400	
Repeatability (mm)		± 0.01	
Deceleration mechanism		Ball screw Φ15	
Ball screw lead (mm)		20	
Maximum speed (mm/sec) *1		1200	
Maximum paylord (kg)	Horizontal installation	50	
	Vertical installation	–	
Rated thrust (N)		312	
Stroke (mm)		Single carrier	500 to 2000 (pitch: 100)
		Double carrier	250 to 1750 (pitch: 100)
Total length (mm)		Stroke length +330	
Width/Height (mm)		145 / 120	
Cable length (m)		3.5 (Standard), 5, 10	
Controller	Horizontal installation	Single carrier	SRCX-20-R/SRCD-20-R/SR1-X
		Double carrier	SRCX-20-R/SRCD-20-R/DRCX/ RCX222HP
	Vertical installation	–	
Robot driver	Horizontal installation	RDX-20-RBR1	
	Vertical installation	–	

* : Maximum speed may not be obtained depending on operating conditions.

■ Tolerable overhang amount *2





● Horizontal installation

(Unit: mm)

		0°	45°	90°
Lead 20	10kg	1082	1316	1855
	30kg	394	568	810
	50kg	256	422	626

● Wall installation

(Unit: mm)

		0°	45°	90°
Lead 20	10kg	1718	750	601
	30kg	621	222	167
	50kg	368	109	78

*2: Distance from center of slider top to center of gravity of object being carried.

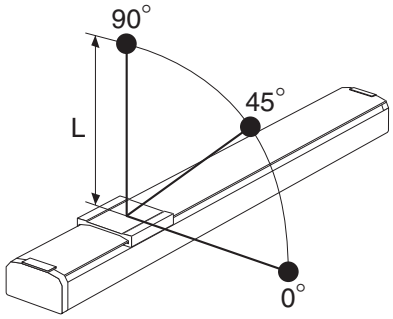
● N18 specifications

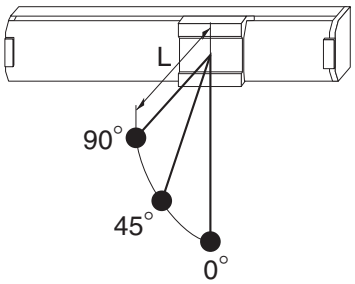
■ Basic specifications

Motor output AC (W)		400	
Repeatability (mm)		± 0.01	
Deceleration mechanism		Ball screw Φ20	
Ball screw lead (mm)		20	
Maximum speed (mm/sec) *1		1200	
Maximum paylord (kg)	Horizontal installation	80	
	Vertical installation	–	
Rated thrust (N)		312	
Stroke (mm)		Single carrier	500 to 2500 (pitch: 100)
		Double carrier	250 to 2250 (pitch: 100)
Total length (mm)		Stroke length +362	
Width/Height (mm)		180 / 115	
Cable length (m)		3.5 (Standard), 5, 10	
Controller	Horizontal installation	Single carrier	SRCX-20-R/SRCD-20-R/SR1-X
		Double carrier	SRCX-20-R/SRCD-20-R/DRCX/ RCX222HP
	Vertical installation	–	
Robot driver	Horizontal installation	RDX-20-RBR1	
	Vertical installation	–	

* : Maximum speed may not be obtained depending on operating conditions.

■ Tolerable overhang amount *2





● Horizontal installation

(Unit: mm)

		0°	45°	90°
Lead 20	30kg	1498	1666	2508
	50kg	897	1037	1736
	80kg	552	665	1277

● Wall installation

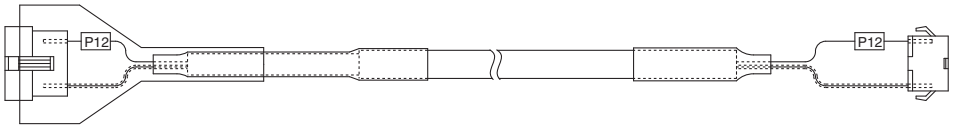
(Unit: mm)

		0°	45°	90°
Lead 20	30kg	2462	977	913
	50kg	1673	596	541
	80kg	1190	370	326

*2: Distance from center of slider top to center of gravity of object being carried.

6-2 Robot connector (I/O signal connector)

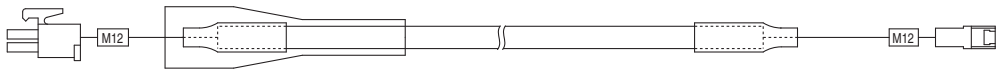
To controller　　To robot



Signal	Connector	No.	Connection	No.	Connector	Remarks	
Encoder S 2	P (1)	1		1	P (3)	Red	0.3sq twisted pair
S 4		2		2		White	
S 1		3		3		Green	
S 3		4		4		White	
R 1		5		5		Yellow	
R 2		6		6		White	
D, G		7		7		Drain wire	

6-3 Robot connector (motor connector)

To controller　　To robot



SIGNAL	Connector No.			Connector No.		NOTE
Motor wire U	M (1)	1		1	M (3)	0.75mm² Red
V		2		2		0.75mm² White
W		3		3		0.75mm² Black
F G		4		4		0.75mm² Green

MEMO

Appendix

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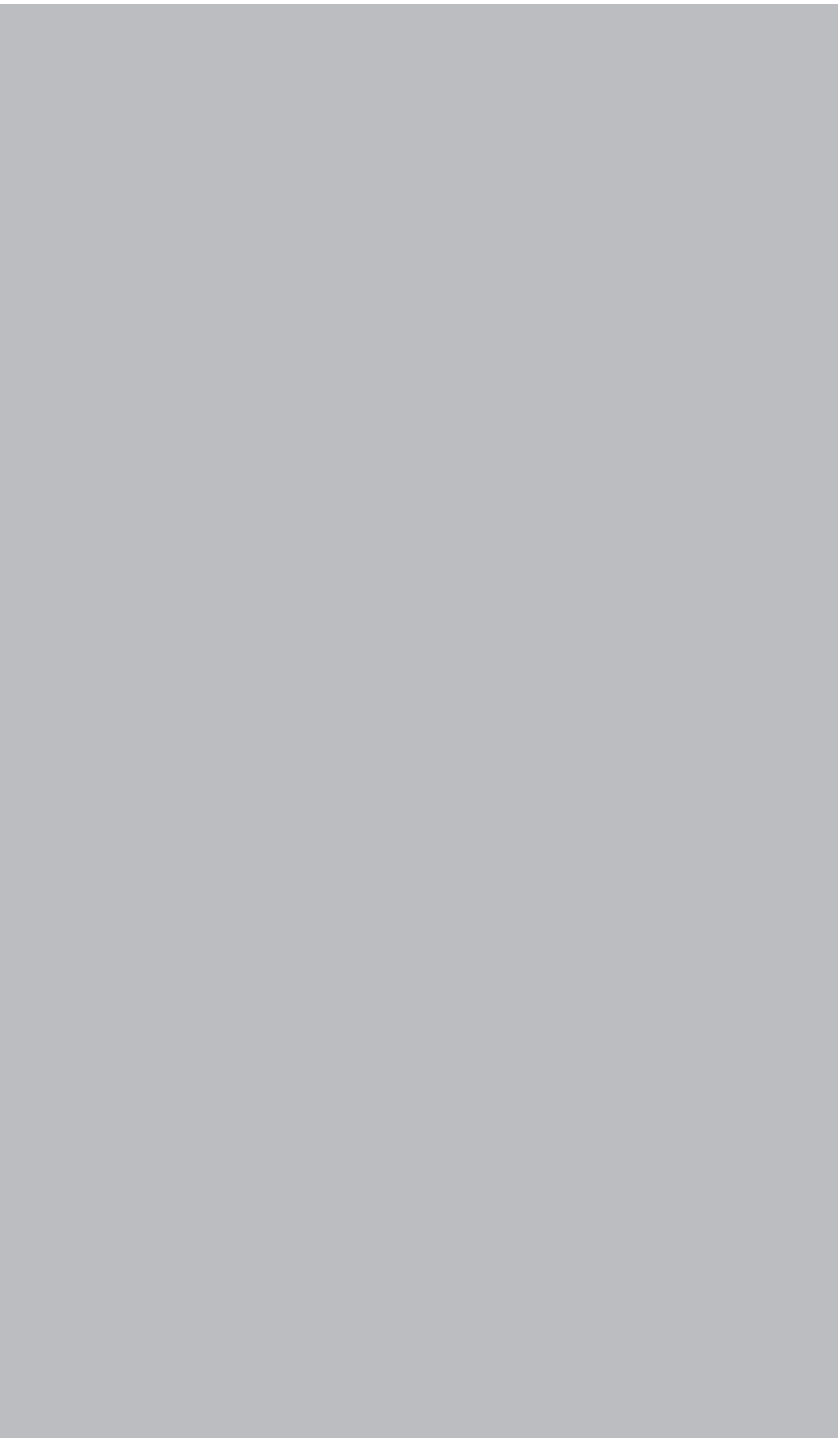
About machine reference i

Moment of inertia calculation ii

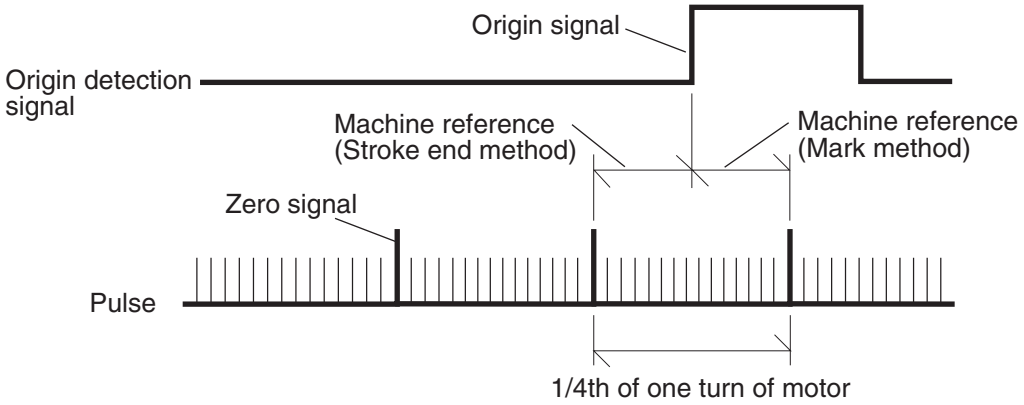


About machine reference

The position detector built into the motor issues a "0" pulse each time the motor rotates 1/4th of one turn. When return-to-origin is performed, a difference in distance occurs between the position where the origin signal is detected and the point at which the next "0" pulse is received. This is called the machine reference and is usually expressed as a percent, with 100% being equal to 1/4th of one turn of the motor. (See the figure below.)
The machine reference value must be within the allowable range (25 to 75%) to maintain axis movement repeatability.
To check the machine reference value, an optional programming unit (HPB or MPB) is needed. The machine reference value is displayed on the LCD screen of the programming unit when return-to-origin is complete. (See the figure below.)

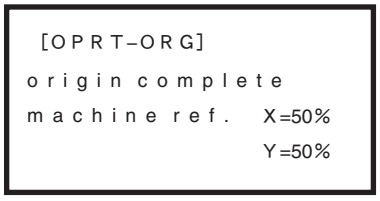
NOTE

The N15/N18 robots use an absolute type position detector. There is no need to perform return-to-origin each time the robot controller is turned on and readjust the machine reference value. If for some reason the machine reference adjustment becomes necessary, please contact YAMAHA sales office or dealer.

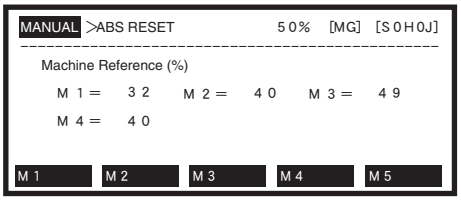


Machine reference value display examples

SRCX



DRCX (Two FLIP-X control)



RCX142 (Multiple FLIP control)

Moment of inertia calculation

CAUTION

The robot must be operated with correct tolerable moment of inertia and acceleration coefficients according to the manipulator tip mass and moment of inertia. If this is not observed, premature end to the life of the drive units, damage to the robot parts or residual vibration during positioning may result.

Usually the R axis load is not a simple form, and the calculation of the moment of inertia is not easy.

As a method, the load is replaced with several factors that resemble a simple form for which the moment of inertia can be calculated. The total of the moment of inertia for these factors is then obtained.

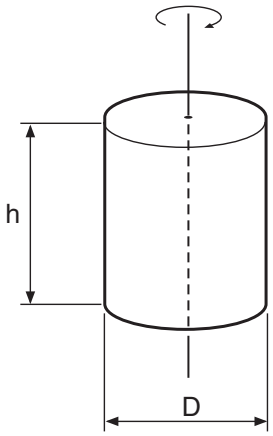
The objects and equations often used for the calculation of the moment of inertia are shown below.

1. Moment of inertia for cylinder

The moment of inertia (J) for a cylinder having a rotation center such as shown below is given by

$$J = \frac{\rho\pi D^4 h}{32g} = \frac{WD^2}{8g} \quad (kgf \cdot cm \cdot sec^2)$$

$$= \frac{mD^2}{8} \quad (kgm^2)$$



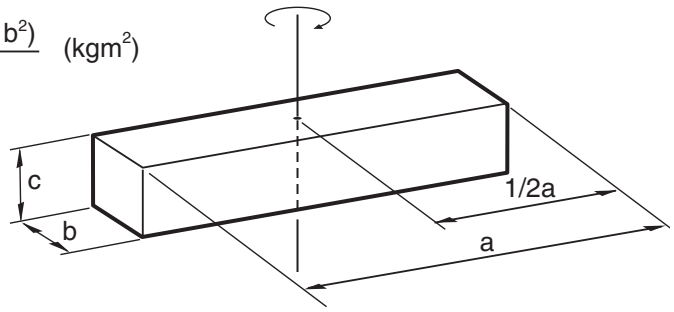
ρ : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
W : Weight of cylinder (kgf)
m : Mass of cylinder (kg)

2. Moment of inertia for rectangular parallelepiped

The moment of inertia (J) for a rectangular parallelopiped having a rotation center as shown below is given by

$$J = \frac{\rho abc\,(a^2 + b^2)}{12g} = \frac{W\,(a^2 + b^2)}{12g} \quad (kgf \cdot cm \cdot sec^2)$$

$$= \frac{m\,(a^2 + b^2)}{12} \quad (kgm^2)$$



ρ : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)
W : Weight of prism (kgf)
m : Mass of prism (kg)

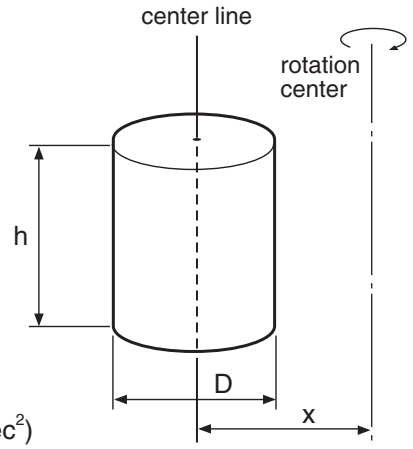
3. When the object's center line is offset from the rotation center.

The moment of inertia (J) when the center of the cylinder is offset by a distance "x" from the rotation center as shown below is given by

$$J = \frac{\rho\pi D^4 h}{32g} + \frac{\rho\pi D^2 hx^2}{4g}$$

$$= \frac{WD^2}{8g} + \frac{Wx^2}{g} \ (kgf \cdot cm \cdot sec^2)$$

$$= \frac{mD^2}{8} + mx^2 \ (kgm^2)$$



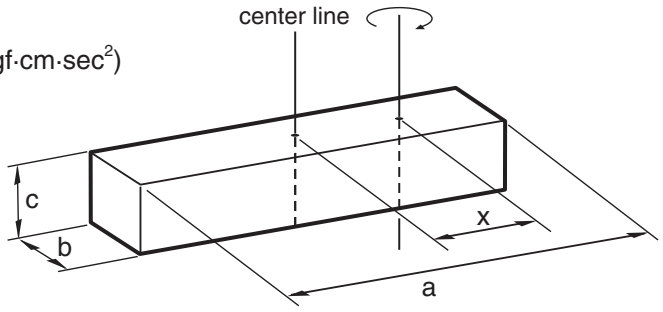
W : Weight of cylinder (kgf)
m : Mass of cylinder (kg)
e : Density (kg/cm^3)
g : Gravitational acceleration (cm/sec^2)

In the same manner, the moment of inertia (J) of a prism as shown below is given by

$$J = \frac{\rho abc\,(a^2 + b^2)}{12g} + \frac{\rho abcx^2}{g}$$

$$= \frac{W\,(a^2 + b^2)}{12g} + \frac{Wx^2}{g} \ (kgf \cdot cm \cdot sec^2)$$

$$= \frac{m\,(a^2 + b^2)}{12} + mx^2 \ (kgm^2)$$



W : Weight of prism (kgf)
m : Mass of prism (kg)

Revision record

Manual version	Issue date	Description
Ver. 1.00	Sep. 2006	English manual Ver. 1.00 is based on Japanese manual Ver. 1.01.
Ver. 1.01	Oct. 2006	English manual Ver. 1.01 is based on Japanese manual Ver. 1.02.
Ver. 1.02	Feb. 2007	English manual Ver. 1.02 is based on Japanese manual Ver. 1.03.
Ver. 1.03	May 2007	English manual Ver. 1.03 is based on Japanese manual Ver. 1.03.
Ver. 1.04	Dec. 2009	English manual Ver. 1.04 is based on Japanese manual Ver. 1.05.

User's Manual

YAMAHA
Single-axis Robot

FLIP-X series
N15/N18

Dec. 2009
Ver. 1.04
This manual is based on Ver. 1.05 of Japanese manual.

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IM Operations

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